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The Stoneflies of the Ozark and Ouachita Mountains (Plecoptera)

BY

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ABSTRACT— Collections of stoneflies (Plecoptera) were made at 603 stream sites from November 1983 - May 1988 in the Ozark- Ouachita Mountain region, in relation to physiographic and vegetational characteristics. Examination of approximately 9,000 vials from these collections, supplemented with material from major museums and other collectors, revealed 88 stonefly species in eight families and 24 genera. Keys and illustrations are provided for all regional species, including descriptions for three new species: *Leuctra paleo, Acroneuria ozarkensis*, and *Perlesta fusca*. Allotypes are designated for *Alloperla ouachita* and *Zealeuctra wachita*, and 12 new nymphal descriptions are provided. A summary table of species presence/absence in relation to 15 natural subregions, six stream order designations, four flow permanence types, and three vegetation types is provided to enhance predictive inferences as to which stonefly species are expected in certain streams. Pearson's measure of association (R) showed there was a significant association between species present and each of the tested variables. Cluster analysis of 126 watersheds elucidated regional divisions based on stonefly species present. A four cluster solution appeared the most biologically meaningful based on knowledge of collection habitats, and had low similarity to 15 natural subregional divisions based on geologic or vegetational characters. The Ozark-Ouachita stonefly fauna most closely resembles that of the Appalachian Mountains and northeastern states, with 49 species common to both regions. Past glacial events, and more specific parameters related to ecological and life cycle requirements such as stream thermal regime and flow permanence, appeared to be the best determinants of species distributions within the region.

INTRODUCTION

There are currently 575 species of stoneflies (Plecoptera) known in North America, representing 99 genera and nine families (Stewart and Stark 1988). They are important components of stream food webs and serve as biological indicators of water quality (Hynes 1972; Resh and Unzicker 1975; Duchrow 1977, 1984; Harper and Stewart 1984; Jones et al. 1981). They contribute substantially to the forage base of many freshwater fishes (White 1975; Healy 1984; Robison and Buchanan 1988), and birds such as nighthawks (Hitchcock 1974). Nymphs of larger species have long been used as bait for bass and trout fishing, and nymphs and adults have been imitated as artificially tied flies by fisherman for over four and a half centuries (McCafferty 1981). Despite their ecological importance in stream ecosystems, the biology of stoneflies is poorly known, and systematic knowledge of the immature stages lags behind the needs of aquatic ecologists for species level identification (Merritt and Cummins 1984; Stewart and Stark 1988). There are particularly large gaps our in knowledge of distributional patterns and species affinities with physiographic, vegetational or other biotic or physical characteristics, and the morphology and biology of immature stages. Except for regional papers by Jewett (1959, Pacific Northwest),

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Ricker (1964, Canada), Stewart et al. (1974, southwestern United States), and Baumann et al. (1977, Rocky Mountains), most stonefly distributional studies in North America have been for political entities (states or provinces). There have been few attempts to systematically sample regions or quantify distributions of species with the goal of achieving predictive inference of their relationships with physiographic provinces, vegetation, types of streams or other biotic or physical characteristics. Recent changes in Plecoptera systematics and new species discoveries have emphasized the need to update knowledge of Plecoptera distributions in most areas of North America.

There have been no comprehensive studies of the stonefly fauna of the Ozark and Ouachita mountain region of eastern North America. Species records and in some cases keys, are available for some states near the region, including Oklahoma (Stark and Stewart 1973b), Texas (Szczytko and Stewart 1977), Lousiana (Stewart et al. 1976), Kansas (Stewart and Huggins 1977), and Illinois (Frison 1929, 1935, 1942). Additional records of Ozark - Ouachita species are available in taxonomic papers (Ross and Ricker 1971; Stark and Stewart 1973a; Stark and Ray 1983; Ernst et al. 1986), from ecological studies of particular stream systems such as the Little Missouri River, Arkansas (Feminella and Stewart 1986), Illinois River, Arkansas (Brown and Ricker 1982), Battle Branch, Oklahoma (Ernst and Stewart 1985b), biotic index studies on Missouri streams (Jones et al. 1981), and other regional studies (Hitchcock 1974). Earlier papers do not include recent taxonomic changes or updated geographical knowledge. Many government publications have little zoogeographic or taxonomic value, since stoneflies are often listed at generic and family levels.

Illies' (1966) catalog attributed 33 and 25 stonefly species to Arkansas and Missouri, respectively. Stewart and Stark (1988) reported 60, 42, and 34 species from Arkansas, Oklahoma, and Missouri, respectively. Frison (1942) listed 27 species from the Illinois Ozarks; the total species list was 67, of which 20 were known from all four states. The families Chloroperlidae (six species), Nemouridae (five species), and Pteronarcyidae (one species), have been poorly represented in the region, and there were no records of Peltoperlidae.

There has been little documentation of stonefly occurrence from the Arkansas River Valley, Gulf Coastal Plain including the Monroe uplift in central Arkansas, Crowleys Ridge in eastern Arkansas and Missouri, and foothill or "border" areas near the Mississippi and Missouri River systems. This intensive regional study, which relies on natural boundaries rather than political divisions and provides quantificaton of species affinities, will be useful to stream ecologists in defining regional Plecoptera fauna and gaining predictive inference as to which species might be expected in the various streams.

Because nymphs are the most frequently encountered life stage during aquatic sampling, there is a particular need for current species level nymphal keys. This is important for stream water quality monitoring, where species identification is nessesary for accurate asessment of community change (Hilsenhoff 1982, 1987).

The major objectives of this study are to provide: 1) a current stonefly species list, 2) keys to nymphs and adults, 3) zoogeographic comparisons between regional and continental distributions, 4) distributional affinities of species with stream order, stream temperature and flow permanence, dominant vegetation types, and physiographic subregions, and 5) new information on the biology, life cycles and nymphal stages of regional species based on the diverse types of habitats in the region.

Description of the Study Area

The Ozark-Ouachita Mountain region encompasses approximately 375,000 km^2, and includes portions of five states (Fig. 1). Stroud and Hanson (1981), Rafferty (1980, 1982), Pflieger (1975), and Robison and Buchanan (1988) have variously subdivided the region based on general topographic features, vegetation, geology, land use, and other ecological factors. A synthesis of these subdivisions was used in this study, and included the following (Fig. 2): 1) Ouachita Mountains, 2) Boston Mountains, 3) Springfield Plain, 4) White River Hills, 5) Central Plateau, 6) Osage-Gasconade Hills, 7) Curtois Hills, 8) St. Francois Mountains, 9) Missouri River Border, 10) Mississippi River Uplands, 11) Illinois Ozarks, 12) Crowley's Ridge, 13) Mississippi River Alluvial Plain, 14) Gulf Coastal Plain, and 15) Arkansas River Valley. Mean annual precipitation varies from 91.4 to 127 cm per year, most occurring in spring and fall (Rafferty 1985). Mean monthly temperatures range annually from lows of 6.6°C in January to highs of 33.3 °C in August (Rafferty 1980).

Major vegetation types noted during this study included 1) upland Pine including Loblolly and Shortleaf (*Pinus* spp.), 2) upland Hardwoods including Oak (*Quercus* sp.) and Hickory (*Carya* sp.), and 3) bottomland Hardwoods including Black Gum (*Nyssa* sp.), Cypress (*Taxodium* sp.), and River Birch (*Betula* sp.). The most common aquatic plant in riffle areas of regional streams was Water Willow (*Justicia* sp.). This plant provided emergence habitat for many stoneflies during spring and summer, and the roots provided habitat and organic material during winter when nymphs were actively growing. The presence of Watercress (*Nasturtium* sp.) at some localities helped suggest the presence of underground springs.

The Ozark-Ouachita mountains were formed during periods of slow uplift near the beginning of the Pleistocene Glaciation (Udvardy 1969). Erosion by streams have formed deep hollows and steep cliffs, resulting in relatively uniform knobs and peaks in comparison to other mountain regions of North America. Elevation ranges from 182-244 m (msl) in lowland areas along the Mississippi River, to 427-855 m (msl) in mountainous areas (Thom and Iffrig 1985). Limestone, the primary sedimentary rock type, underlies over 80% of the region, but exposed areas of sandstone, dolomite, shale, chert, granite, and rhyolite also occur in the region (Rafferty 1985). Fragments of chert and dolomitic limestone predominate among stream substrates. When loosely packed, these may permit significant interstitial flow without surface flow (Clifford 1966). An exchange between surface water and groundwater often results in "losing" streams, where surface flow may partially disappear underground (Thom and Iffrig 1985) and reappear elsewhere as springs. Other features which occur in the region include caves, springs, sinkholes, and natural bridges.

A majority of small regional streams (orders 1-3) consisted of intermittent pools or a completely dry stream bed during parts of the summer months. Some 4th-5th order streams in the Ouachita Mountains, which flow through valleys between elongate east-west hills, were slow, murky and became intermittent during summer. Intermittent streams and those that dry up completely during certain seasons have stonefly species with dessicant-resistant, diapausing eggs (Snellen and Stewart 1979a). Some permanent streams result from undergound springs, which substantially altered the stream temperature regime (Fig. 3). Areas in the Springfield Plain, Central Plateau, and Curtois Hills contain some of the largest springs in the United States (Vinyard and Feder 1974). Big Spring (mean cms=12.3) and Greer Spring (mean cms=9.5) are the two largest in the region (USGS 1974), and their sources have been traced with dye from "losing" streams up to 88 km away (David Foster, pers. comm.).

Most streams in the Mississippi Alluvial Plain have been heavily channelized and suffer from organic pollution due to agricultural enrichment (Duchrow 1977, Robison and Buchanan 1988). Non-point source pollution, often from agriculture, is evident in regional subdivisions with low relief such has the Springfield Plains, Missouri River Border, and Central Plateau (Duchrow 1984). These areas probably act as dispersal barriers for some less vagile and tolerant stonefly species.

Materials and Methods

Stoneflies were collected monthly from November 1983 to June 1988. Trips were planned to coincide with occurrence of pre-emergent nymphs (for rearing) and adult emergence. Detailed county maps from the Departments of Transportation of Arkansas, Missouri, and Oklahoma were used to subdivide the region into watersheds based on 4th and 5th order streams (Fig. 4, Table 1). Natural "breaks" in conditions such as gradient and regulation were used in a method similar to that of Matthews and Robison (1988). Collection sites were selected along accessable transects traversing a full array of stream orders within each major watershed. Unique habitats such as waterfalls, springs, and cave streams, "typical" streams representing each physiographic subregion, and those which contained high stonefly diversity were repeatedly sampled. Collections were made from a total of 603 stream sites, providing substantial coverage of the region (Fig. 1). Stoneflies were present in 523 of these sites, and repeat collections were made from 191 of them. Collections from some sites near Springfield, Missouri and Fayetteville, Arkansas were made by other researchers, and these specimens were available from collectors or through various museums.

During collection periods, the following variables were recorded for each location sampled: 1) approximate stream width, depth, and current velocity, 2) dominant surrounding vegetation, 3) stream substrate type, 4) surrounding topography, 5) indication of organic enrichment, and 6) flow permanence. In this study, water temperature was combined with the flow permanence variable. Water temperature was measured with a total immersion °C thermometer, and flow permanence was noted during summer and fall seasons. Because life cycle requirements can be related to flow permanence and degree of stream hydration (Snellen and Stewart 1979a), a distinction was made between intermittent (standing pools without surface flow) and dry (completely dry stream bed) streams during sampling and analysis.

Methods of collecting stoneflies included: 1) disturbance of stream substrates directly upstream from a rectangular-framed kick net, 2) sweeping/beating riparian vegetation with a sweep net, 3) searching emergent leaves, snags, bridges, fenceposts, stones, and spider-

Fig. 1. The Ozark-Ouachita Mountain region, showing major rivers and their tributaries. Closed circles represent collection sites made during the current study, and open circles represent records from other collections. The dashed line depicts the southern limit of the Kansian glacial lobe.

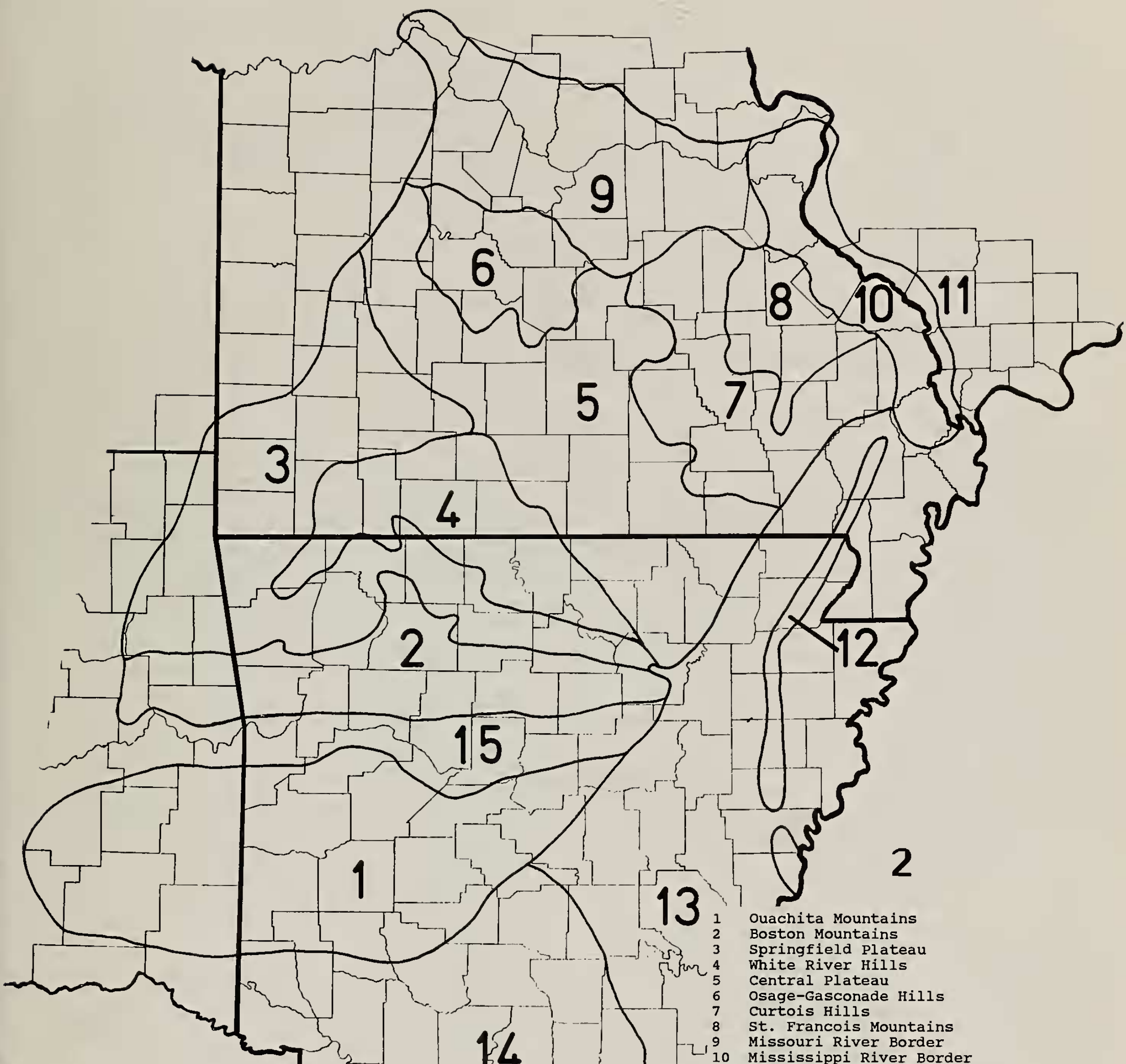


Fig. 2. Natural subregions within the Ozark- Ouachita Mountains.

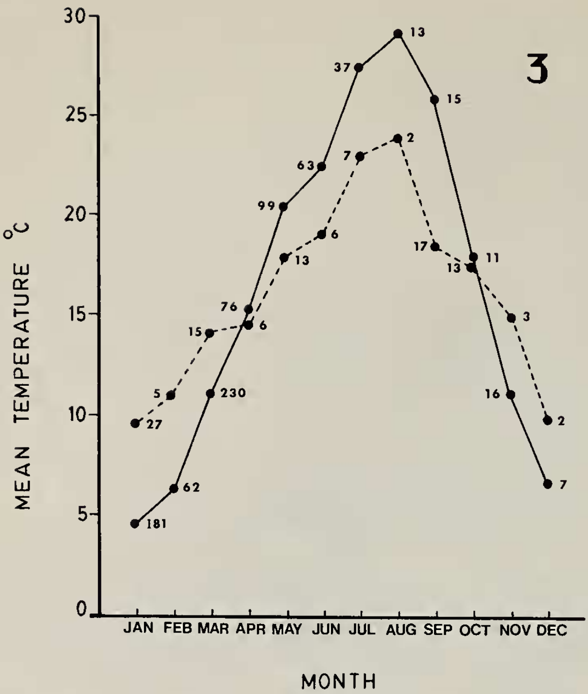


Fig. 3. Plot of mean monthly water temperatures in Ozark-Ouachita Mountain streams from Nov. 1983-May 1988. Streams with significant flow from underground springs are represented by the dashed line, and those without permanent spring flow are represented by the solid line. Integers next to data points indicate the total number of streams sampled each month.

Table 1. List of the 126 Ozark-Ouachita watershed divisions shown in Figure 4.

1. Upper Fourche la Fave
2. Piney Creek
3. Big Creek
4. Flint Creek
5. Lower Poteau River
6. Bodcau Creek
7. Maumelle River
8. Richland and Bear Creeks
9. Big Piney Creek
10. Magazine Mountain
11. Cypress Creek
12. Cornie Creek
13. Upper Ouachita River -II
14. Cossatot River
15. Caney Creek
16. Upper Moro Creek
17. Upper Little Missouri River
18. South Fourche la Fave
19. Little Petit Jean Creek
20. Frog Bayou
21. South Cadron Creek
22. Fourche Creek
23. Sylamore Creek
24. Mississippi River (lowland)
25. War Eagle Creek
26. Crooked Creek
27. Point Remove Creek
28. White River (Beaver, Table Rock, Taneycomo Reservoirs)
29. Terre Rouge Creek
30. Smackover Creek
31. Rolling Fork Creek
32. White River (Bull shoals Reservoir)
33. Middle Fourche la Fave
34. North Cadron Creek
35. Illinois Bayou
36. Upper Illinois River
37. Upper Petit Jean Creek
38. North Fork White River
39. Lower Little Missouri River
40. Cypress Bayou and Bayou des Arc
41. South Fork Spring River
42. Middle Fork Little Red River
43. South Fork Little Red River
44. Mulberry River
45. Lee Creek
46. Upper Saline River
47. Eleven Point River
48. Saline River
49. Caddo River
50. Middle Saline River
51. Lower Moro Creek
52. Strawberry River
53. Spring River
54. Lower Little Red River
55. Buffalo River
56. Upper Ouachita River. - I
57. Middle Ouachita River - I
58. Middle Ouachita River - II
59. Red River and Sulphur River
60. Little River
61. Antoine River
62. Lower Ouachita River
63. Lower Saline River
64. Tulip Creek
65. Kings River
66. Sugar Creek
67. Lower Black River
68. Lower Current River
69. Lower White River -II
70. Crowley's Ridge
71. Upper White River
72. Lower White River - I
73. Upper Poteau River
74. Mountain Fork River
75. Lower Arkansas River
76. Brushy Creek
77. Kiamachi River
78. Upper Little River.
79. Glover River
80. Fourche Maline Creek
81. Lower Illinois River
82. Canadian River
83. Spavinaw Creek
84. Lower Neosho River
85. Upper Black River
86. Castor River and White-water River
87. Lower Osage River
88. Missouri River
89. Mississippi River (upland)
90. Arkansas River
91. Big Creek
92. Flat Creek
93. Little Piney Creek
94. Cache River
95. Bryant Creek
96. Bull Creek & Swan Creek
97. Finley Creek
98. Little Black River
99. Curtois Creek and Huzzah Creek
100. Jack's Fork River
101. Moreau River
102. Elk River
103. Shoal Creek
104. St. Francis River
105. Kaskaskia River and Big Muddy River
106. Lower Ohio River
107. Lower Gasconade River
108. Bourbouse River
109. Lower Meramec River
110. Big River
111. Maries River
112. Lamine River and Petit Saline River
113. Upper Osage River
114. Lower Sac River
115. Pomme de Terre River
116. Niangua River
117. Osage Fork Gasconade River
118. Upper Sac River
119. Spring River
120. James River
121. Beaver Creek
122. Upper Gasconade River
123. Big Piney River
124. Upper Current River
125. Upper Meramec River
126. Saline River

Fig. 4. Natural watershed divisions within the Ozark- Ouachita Mountains. Watersheds are listed in Table 1.

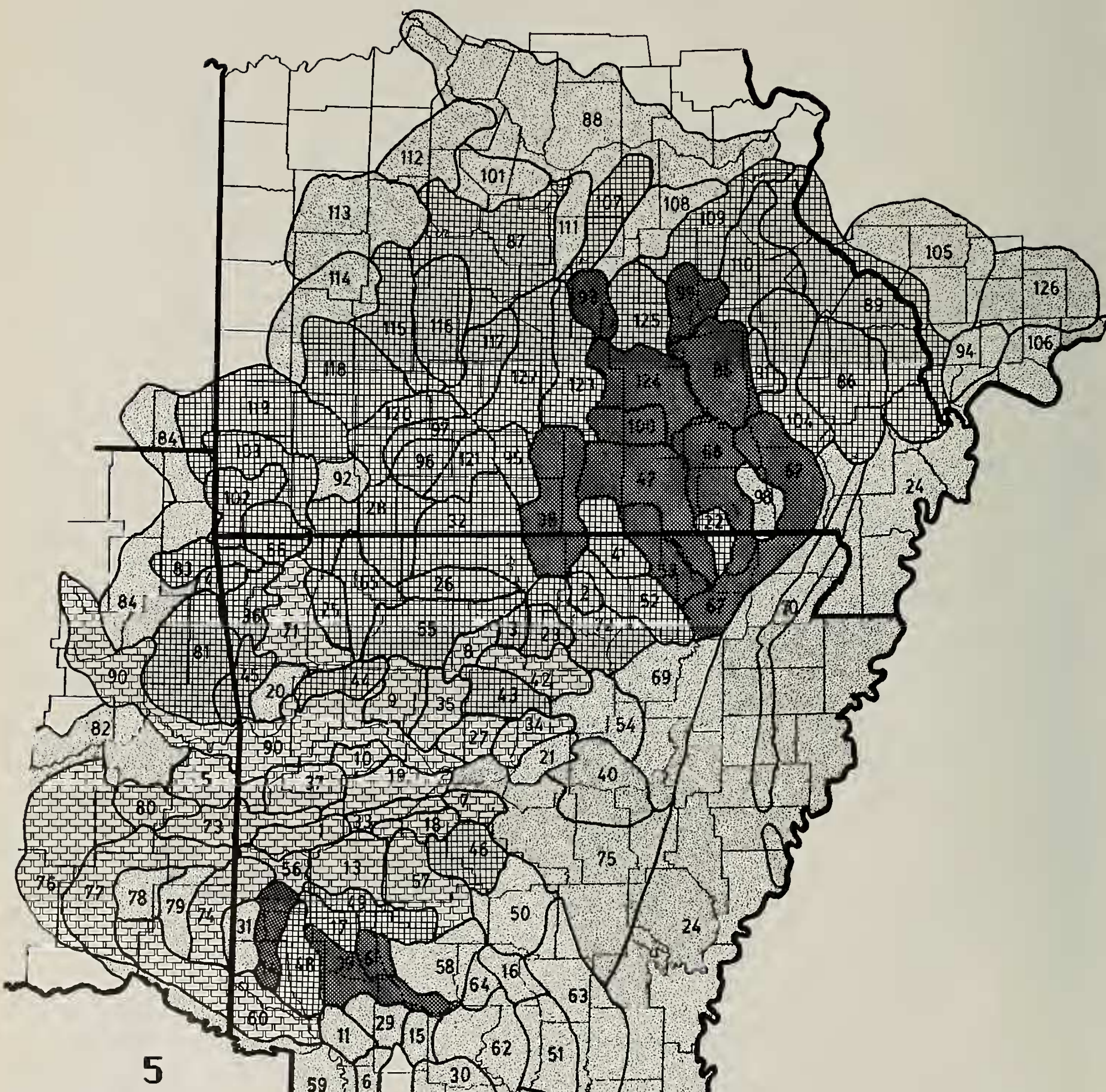


Fig. 5 Watershed clusters in the Ozark-Ouachita Mountains. Each cluster represents faunistically similar watersheds based on stonefly species present. Watersheds are listed in Table 1.

webs for exuviae and adults, and 4) light trapping with a Bioquip Universal Light-trap and eight-watt fluorescent blacklight, or a Ray-o-Vac Sportsman lantern with black bulbs set up on a white cloth sheet at dusk. An aspirator constructed of 3 cm dia. plastic tubing, neoprene stoppers, 1.0 cm Tygon tubing, and Nitex was used to facilitate collection of adults and exuviae.

All specimens were initially preserved with 75% ethanol or 70% isopropanol in six dram screw-capped vials and labeled with site numbers and date. They were then sorted, identified, labeled, and transferred into fresh 80% ethanol or isopropanol within one to three weeks.

Nymphs were reared in the field or transported live to the laboratory in small portable styrofoam "six-pack" drink coolers containing stream water (Szczytko and Stewart 1979). Each of the six cylindrical compartments was eight cm dia. x 11 cm depth, and nymphs were enclosed in them with tight fitting styrofoam cups. During warm months, water was changed daily or as needed during transport, and these smaller coolers were transported with ice inside larger ice chests. Nymphs were then transferred into rearing cages housed in laboratory living streams (Frigid Units, Inc.) set to simulate seasonal stream temperature changes (Stewart and Stark 1988). Rearing cages consisted of tall cylindrical baskets made of metal screen or plastic mesh set into the water column of the artificial stream and weighted with gravel, or styrofoam cups with side windows cut out and replaced with screening and floated in the water column with styrofoam sheets. Rearing enabled correlation of unknown nymphs with adults, and provided nymphal study material necessary for constructing keys.

Males were prepared for study by the following techniques: 1) aedeagi of *Perlesta*, *Acroneuria*, *Isoperla*, *Paragnetina*, and some *Taeniopteryx* were extruded in the field by gently rolling and squeezing the middle abdominal seqments between thumb and forefinger, then holding the specimen by its terminal segments with a forceps while immersing it in alcohol until death, and fixing the extruded aedeagus (Stark 1990a), 2) aedeagi of unextruded, preserved adults in these same taxa were prepared by boiling the terminal abdominal segments in hot 10% KOH for two to eight minutes or until soft tissue was cleared or loosened from the segments. Eversion of some preserved *Isoperla* aedeagi was achieved by using methods outlined by Szczytko and Stewart (1979), and those of *Neoperla* and *Acroneuria* were studied utilizing methods outlined by Stark and Gaufin (1976) and Stark and Baumann (1978). The aedeagi of some *Acroneuria* were also extruded from KOH - cleared specimens by pulling them inside-out with a fine forceps, but male aedeagi of *Perlesta* had to be field-extruded to be of taxonomic value.

Nymphal mouthparts and chorionic sculpturing of "in uteri" eggs, were examined using a Jeol JSM T300 Scanning Electron Microscope. Adult and nymphal identification, general mouthpart characters, and some egg characters were determined using an Olympus JM Stereomicroscope with an Olympus LSG lighting attachment. Specimens were prepared for drawing by pinning in the appropriate orientation or holding with No. 1 insect pins molded to pieces of lead. Line drawings were completed on poster board with Staedler technical pens (0.018, 0.025, 0.030, 0.045) and color patterns were drawn and shaded on stipple board with pencil. Key characters were drawn with the aid of a Wild M- 5 stereomicroscope with drawing attachment. Approximately 9000 vials of stoneflies were examined during this study, and over half of them are deposited at the UNT Aquatic Insect Museum. Voucher specimens have also been deposited at the following museums: UWSP, BYU, SAU, MC, ASU, UM, INHS, and the USNM (for key to abbreviations, see end of this section).

Stonefly presence/absence was recorded on a species checklist for each of the 126 watersheds, and used in a computerized cluster analysis (Norusis 1985). This analysis generated a dendrogram and 2-15 clusters of faunistically similar watersheds. The most biologically meaningful solution (number of clusters) was chosen based on cluster distance and gaps in the dendrogam that represented the most natural differences in stonefly requirements based on stream characteristics in the clustered regions. This solution was used to provide general comparisons with subregional groupings (Stroud and Hanson 1981; Rafferty 1985), and other regional faunistic studies (Matthews and Robison 1988). It was assumed that a grid of streams where stoneflies were collected represented a reasonable sample of all streams present, and yielded a realistic frequency of occurrence for each species. Since variables in this study (permanence, subregion, presence/absence, vegetation type) were discrete, a crosstabulation procedure (Norusis 1985) provided the most appropriate descriptive relationships between species presence and stream characteristics or geographic areas. This analysis generated numerical cell frequencies for each combination of variables, and Chi Square and Pearsons associations (R) between species present and subregion, stream order, vegetation, and stream type based on temperature and flow permanance. Procedure Log- Linear (Norusis 1985) was used to analyze the natural log of these cell frequencies to generate a model. However, since statistical significance cannot be substituted for biological significance when presence/absence data are used, statistical results from this procedure was not emphasized in this study.

Other stoneflies were obtained from major museums and collectors. Specimens were examined from the Wilbur E. Enns Museum at the University of Missouri (UM), the Illinois Natural History Survey Museum, at the University of Illinois (INHS), and the National Museum of Natural History (USNM).

Individuals and their university, or institutional affiliations,that provided loans of or access to specimens included: Dr. O. S. Flint, Jr., (USNM); Dr. S. W. Szczytko (SWS), University of Wisconsin, Stevens Point (UWSP); Dr. B. P. Stark (BPS), Mississippi College (MC); Dr. R. W. Baumann (RWB), Brigham Young University (BYU); Dr. H. W. Robison (HWR), Southern Arkansas University (SAU); Dr. G. L. Harp, Arkansas State University (ASU); Dr. A. V. Brown (AVB), University of Arkansas (UA); L. Trial, Missouri Dept of Conservation (LT); and R. McDaniel, Arkansas Dept. of Pollution Control and Ecology (RM). Other individuals who provided specimens included: J. W. Feminella (JWF), O. & M. Hite (Hite), E. J. Bacon (EJB), and B. J. Armitage (BJA). Our collections are abbreviated as (BCP) and (UNT).

Results

Eight families, 24 genera, and 88 species of Plecoptera are currently known from the Ozark-Ouachita Mountain region (the 25 regional endemic species are in bold face type):

OZARK-OUACHITA PLECOPTERA SPECIES LIST

- Euholognatha
  - Family Capniidae
    - Subfamily Capniinae
      - *Allocapnia forbesi* Frison
      - *Allocapnia granulata* (Claassen)
      - ***Allocapnia jeanae*** Ross
      - *Allocapnia malverna* Ross
      - ***Allocapnia mohri*** Ross and Ricker
      - *Allocapnia mystica* Frison
      - ***Allocapnia oribata*** Poulton and Stewart
      - ***Allocapnia ozarkana*** Ross
      - ***Allocapnia peltoides*** Ross and Ricker
      - *Allocapnia pygmaea* (Burmeister)
      - *Allocapnia rickeri* Frison
      - ***Allocapnia sandersoni*** Ricker
      - *Allocapnia smithi* Ross and Ricker
      - *Allocapnia vivipara* (Claassen)
      - ***Allocapnia warreni*** Ross and Yamamoto
      - *Nemocapnia carolina* Banks
      - *Paracapnia angulata* Hanson
  - Family Leuctridae
    - Subfamily Leuctrinae
      - ***Leuctra paleo*** Poulton and Stewart
      - *Leuctra rickeri* James
      - *Leuctra tenuis* (Pictet)
      - ***Zealeuctra cherokee*** Stark and Stewart
      - *Zealeuctra claasseni* (Frison)
      - *Zealeuctra fraxina* Ricker and Ross
      - *Zealeuctra narfi* Ricker and Ross
      - ***Zealeuctra warreni*** Ricker and Ross
      - ***Zealeuctra wachita*** Ricker and Ross
  - Family Taeniopterygidae
    - Subfamily Brachypterinae
      - ***Strophopteryx*** **arkansae** Ricker and Ross
      - ***Strophopteryx cucullata*** Frison
      - *Strophopteryx fasciata* (Burmeister)
    - Subfamily Taeniopteryginae
      - *Taeniopteryx burksi* Ricker and Ross
      - *Taeniopteryx lita* Frison
      - *Taeniopteryx lonicera* Ricker and Ross
      - *Taeniopteryx maura* (Pictet)
      - *Taeniopteryx metequi* Ricker and Ross
      - *Taeniopteryx parvula* Banks
  - Family Nemouridae
    - Subfamily Amphinemurinae
      - *Amphinemura delosa* (Ricker)
      - *Amphinemura nigritta* (Provancher)
    - Subfamily Nemourinae
      - *Prostoia completa* (Walker)
      - *Prostoia similis* (Hagen)
      - *Shipsa rotunda* (Claassen)
- Systellognatha
  - Family Chloroperlidae
    - Subfamily Chloroperlinae
      - Tribe Alloperlini
        - ***Alloperla caddo*** Poulton and Stewart
        - *Alloperla caudata* Frison
        - *Alloperla hamata* Surdick
        - *Alloperla leonarda* Ricker
        - ***Alloperla ouachita*** Stark and Stewart
      - Tribe Chloroperlini
        - *Haploperla brevis* (Banks)
  - Family Perlidae
    - Subfamily Acroneuriinae
      - Tribe Acroneuriini
        - *Acroneuria abnormis* (Newman)
        - *Acroneuria evoluta* Klapalek
        - *Acroneuria filicis* Frison
        - *Acroneuria internata* (Walker)
        - *Acroneuria mela* Frison
        - ***Acroneuria ozarkensis*** Poulton and Stewart
        - *Acroneuria perplexa* Frison
        - *Attaneuria ruralis* (Hagen)
        - ***Perlesta baumanni*** Stark
        - ***Perlesta browni*** Stark
        - *Perlesta cinctipes* (Banks)
        - *Perlesta decipiens* (Walsh)
        - ***Perlesta fusca*** Poulton and Stewart
        - *Perlesta shubuta* Stark
        - *Perlinella drymo* (Newman)
        - *Perlinella ephyre* (Newman)
    - Subfamily Perlinae
      - Tribe Neoperlini
        - *Neoperla carlsoni* Stark and Baumann
        - *Neoperla catharae* Stark and Baumann
        - *Neoperla choctaw* Stark and Baumann
        - ***Neoperla falayah*** Stark and Lentz
        - ***Neoperla harpi*** Ernst and Stewart
        - ***Neoperla osage*** Stark and Lentz
        - ***Neoperla robisoni*** Poulton and Stewart
      - Tribe Perlini
        - *Agnetina capitata* (Pictet)

Agnetina flavescens (Walsh)
Paragnetina kansensis (Banks)
Paragnetina media (Walker)
Family Perlodidae
Subfamily Isoperlinae
Clioperla clio (Newman)
Isoperla bilineata (Say)
Isoperla burksi Frison
Isoperla coushatta Szczytko and Stewart
Isoperla decepta Frison
Isoperla dicala Frison
Isoperla mohri Frison
Isoperla namata Frison
Isoperla ouachita Stark and Stewart
Isoperla signata (Banks)
Isoperla szczytkoi Poulton and Stewart
Subfamily Perlodinae
Helopicus nalatus (Frison)
Hydroperla crosbyi (Needham and Claassen)
Hydroperla fugitans (Needham and Claassen)
Family Pteronarcyidae
Subfamily Pteronarcyinae
Pteronarcys pictetii Hagen

Some rare species historically reported from areas surrounding the region, or those that could not be confirmed due to the unavailability of specimens, such as *Amphinemura varshava* (Ricker), *Isoperla longiseta* Banks, and *Isoperla montana* (Banks) are not included in this list. *Perlesta placida* (Hagen) and *Neoperla clymene* (Newman) are also omitted, but are noted in the Perlidae species accounts because of the large numbers of museum specimens that remain so labeled.

A cross-tabulation of the frequency of occurrence for each species within the 15 subregions, six stream order categories, four flow permanence/temperature types, and three vegetational types contained a total of 3301 entries. A measure of association (Pearson's R) was calculated with species present as the dependent variable, and gave the following significance ($P<0.05$) for each independent variable: 1) subregion ($R=0.028$), $p = 0.049$, 2) stream order ($R=0.219$), $p < 0.001$, 3) stream permanence ($R=0.214$), $p < 0.001$, and 4) vegetation ($R=0.056$), $p = 0.01$, indicating that there was a significant association between the species present, and each of the tested variables. A Log-linear model including all variables and the properly selected interaction terms generated an overall significance at the $\alpha = 0.05$ level of $P < 0.01$. Because of the high percentage (range 53.7 to 85.5% for the four variables) of cells with an expected frequency of < 5, testing of individual cell frequencies with this method, and therefore individual associations, is invalid at this time. However, the cross- tabulation of presence/absence data provided useful descriptive information.

The summary table (Table 2) including number of records, and the species expected within subregions under certain stream conditions is intended to provide general predictive information of species presence for the region. When a species appeared to be associated with particular subregions, thermal regimes, flow permanence types, or vegetation types, parenthetical numbers were given in Table 2 to show the percentage of the total species records corresponding with that character. For example, of the total number of records for *Paragnetina media*, 80 % were from subregions 5 (Central Plateau) and 7 (Curtois Hills), 100 % were from stream orders 1-5 with no apparent preference for stream size, 90 % were from permanent streams containing spring inputs (type D), and 100 % were from localities containing either upland hardwoods (type 2) or pine (type 1) as the predominant vegetation type. Subregion (1-15, Fig. 2, Table 1) best predicted the presence of endemic species, and those that were found under conditions characteristic of a particular subregion. For example, permanent springs were most common in subregions 3 (Springfield Plateau), 5 (Central Plateau), and 7 (Curtois Hills) due to their geology. These subregions contained many species under flow permanence type D in Table 2 (permanent streams containing spring flow). Stream order (1-6+) and vegetation type (1-3) are related to stream size and the forms of food available during nutrient cycling. Small streams (orders 1-3) were found with upland vegetation and more often became intermittent than did larger streams (orders 4-6). Therefore, these variables best predicted the presence of species common in intermittent habitats and larger streams that contained lowland vegetation. In this study, the flow permanence variable was combined with thermal regime because of its close relationship to the presence of permanent, underground springs. Flow permanence type was the best predictor of stonefly presence and provided the most valuable inferences of life cycle requirements.

Stonefly emergence occurred throughout the year, with the highest diversity during winter and spring, and lowest diversity during September and October (Table 4). Streams with high stonefly diversity could have adults emerging during every week of the year. Since many regional species are known to emerge synchronously (Ernst & Stewart 1985b), black bars in Table 4 probably reflect periods of adult presence rather than emergence. Since basic ecological requirements may be similar in other regions, Tables 2 and 4 may provide useful data for biologists throughout eastern North America.

The Ouachita Mountain subregion was the most diverse, with 56 stonefly species known, including 19 of

Table 2. Ozark-Ouachita Plecoptera table, including total number of collection records for each species (N), and their presence in different subregions, stream orders, flow permanence types, and vegetation types. Numbers and letters under each variable represent 100% of N for that species, unless otherwise indicated in parentheses.

Species	N	Subregion	Stream Order	Flow Permanence	Vegetation	Clusters 1	2	3	4
Acroneuria abnormis	3	10,11	6+	C	3	U		X	
Acroneuria evoluta	140	1-11	1-6+	C,D(87)	1,2(98)	U	C	C	C
Acroneuria filicis	15	1-8,11,13-15	2-5	C,D(93)	1,2,3	U	C	C	U
Acroneuria internata	17	1-3,5-7,9	3-6+	C,D	1,2(94)	X	X	U	U
Acroneuria mela	10	2,6,13-15	3-6+	C	3(80)	C	U	X	U
Acroneuria ozarkensis	2	2,9	5,6+	C	2,3			U	
Acroneuria perplexa	44	1-3,5,7(82)	3-5(86)	C,D(96)	1,2(91)	C	C	C	C
Agnetina capitata	13	3-7	1-4	D(85)	1,2	X		U	C
Agnetina flavescens	56	1-9,15	1-5	C,D	1,2(98)	X	C	C	C
Allocapnia forbesi	3	11	2-4	B,C	2	X			
Allocapnia granulata	116	1-11,13-15	1-6+	C(74)	1,2(94)	C	C	C	C
Allocapnia jeanae	9	1-4,10,15	1-3	A,B(89)	1(78)	X	U	U	
Allocapnia malverna	35	14(97)	1,2(77)	A,B(94)	1(91)	C	X		X
Allocapnia mohri	102	1-5,15(89)	1-5	A,B,C(96)	1,2(96)	U	C	C	C
Allocapnia mystica	53	1,3-5,7-12	1-5	A,B,C,D	1,2(92)	U	C	C	C
Allocapnia oribata	2	2	4	C	1		U	U	
Allocapnia ozarkana	2	14,15	1-3	B	1	X	U		
Allocapnia peltoides	10	1	1-4	A,B(90)	1,2,3		U	X	
Allocapnia pygmaea	6	6,7,11	2-4	C,D	1,2(83)			U	U
Allocapnia rickeri	145	1-11,13-15	1-5	B,C(89)	1,2(97)	U	C	C	C
Allocapnia sandersoni	9	3,4,5	2-4	B,C(89)	2(67)		U	U	
Allocapnia smithi	1	11	3	C	2	X			
Allocapnia vivipara	53	3,9-11(91)	1-3(93)	A,B,C	2,3(98)	C		C	X
Allocapnia warreni	1	3	3	C	2			U	
Alloperla caddo	4	1	1-3	A,B,C	1		U	X	
Alloperla caudata	33	1-10,15	1-5	B,C,D	1,2(91)	U	C	C	C
Alloperla hamata	2	2,4	2,3	B,C,D	1			U	
Alloperla leonarda	1	4	3	D	1			U	
Alloperla ouachita	2	1	2	C	1			U	
Amphinemura delosa	97	1-12,14,15	1-3(92)	A,B,C,D	1,2(97)	C	C	C	C
Amphinemura nigritta	3	9,13	1-3	A,B,C	1,2	U			
Attaneuria ruralis	4	10,11,13	6+	C	3	U		U	U
Clioperla clio	258	1-11,13-15	1-5	A,B,C,D	1,2,3	C	C	C	C
Haploperla brevis	88	1-15	1-5	A,B,C,D	1,2(95)	U	C	C	C
Helopicus nalatus	32	1-3,5,8(84)	2-5	C(97)	1,2	X	C	C	C
Hydroperla crosbyi	96	1,3,5,9,15(84)	1-5	A,B,C,D	1,2(97)	C	C	C	C
Hydroperla fugitans	2	10	6+	C	3			U	
Isoperla bilineata	9	9-11	6+(78)	C	2,3	U		X	
Isoperla burksi	18	1,2,11,15(81)	3,4(94)	C(95)	1,2	X	C	U	
Isoperla coushatta	19	12,14(84)	1-5	A,B,C	1,2(84)	C		X	
Isoperla decepta	23	6,9-11	1-4	B,C(96)	2(96)	C		C	
Isoperla dicala	13	5,7(93)	1-5	D	1,2			U	C
Isoperla mohri	77	1,5,9,12,14,15(76)	1-3(91)	A,B,C	1,2(91)	C	C	C	U
Isoperla namata	121	1-8(96)	1-5	C,D(84)	1,2(98)	X	C	C	C
Isoperla ouachita	167	1-10,13-15	1-5	A,B,C(96)	1,2(97)	X	C	C	C
Isoperla signata	17	3,7(82)	2-5	C,D	1,2			C	C
Isoperla szczytkoi	1	1	1	A	1		U		
Leuctra paleo	2	14	2	C	1	U			
Leuctra rickeri	3	11	2-3	C	2	U			
Leuctra tenuis	34	1-8	1-4	C,D(94)	1,2			C	C
Nemocapnia carolina	1	1	2	C	1			U	
Neoperla carlsoni	7	1,2,6,14,15	3-5	C,D	1,2,3	X	U	U	
Neoperla catharae	20	1,3,5,7,8,14	2-5	C(95)	1,2	U		C	C
Neoperla choctaw	15	1-3,5,9,14,15	2-5	C(87)	1,2,3	U	U	U	
Neoperla falayah	64	1-10,14	3-5(89)	C,D(98)	1,2,3	C	C	C	C
Neoperla harpi	42	1-10,14,15	2-5	C,D(93)	1,2(98)	C	C	C	C
Neoperla osage	42	1-10	1-5	C,D(98)	1,2(98)	C	C	C	C
Neoperla robisoni	24	1-9,14	4-6+	C,D	1,2,3	C	C	U	U
Paracapnia angulata	18	1,3,4,7	1-4	C,D	1,2			C	C
Paragnetina kansensis	9	5,7,13-15	5,6+(89)	C,D	1,2,3			U	U
Paragnetina media	20	5,7(80)	1-5	D(90)	1,2			U	C
Perlesta baumanni	4	1	1-4	A,B	1,2		U	X	
Perlesta browni	18	1-5,8,9,14,15	4,5(78)	B,C	1,2(94)	C	C	C	C

Perlesta cinctipes	26	1,3,5,9,15(93)	1-4	A,B,C	1,2,3	C	C	C	C
Perlesta decipiens	119	1-15	1-6	A,B,C,D	1,2(94)	C	C	C	C
Perlesta fusca	22	1,2,15(83)	1-3(95)	A,B(86)	1,2(95)	U	C	U	U
Perlesta shubuta	14	3,5,7,10	2-5	C,D	1,293)			U	C
Perlinella drymo	57	1-15	1-6+	A,B,C,D	1,2(95)	C	C	C	C
Perlinella ephyre	48	1-8(94)	2-5(94)	C,D(94)	1,2,3	C	C	C	C
Pro̖stoia completa	88	1-8(90)	1-5	C,D(99)	1,2(99)	X	C	C	C
Prostoia similis	4	7	2,3	C	1U				
Pteronarcys pictetii	37	5,7(74)	4-6+(79)	C,D	1,2,3	U		U	C
Shipsa rotunda	1	14	3	C	3	U			
Strophopteryx arkansae	42	1,2,8(86)	1-4	B,C(98)	1(83)		C	U	C
Strophopteryx cucullata	96	1,2,15(82)	1-4	A,B,C	1,2(98)	X	C	C	U
Strophopteryx fasciata	130	1-11,5	1-6+	C,D(95)	1,2(98)	U	C	C	C
Taeniopteryx burksi	105	1-11,14,15	1-6+	C,D(87)	1,2,3	U	C	C	C
Taeniopteryx lita	11	1,5,10,11,13,15	4-6+(82)	C(91)	1,2,3	U	U	U	U
Taeniopteryx lonicera	1	14	3	C	3	U			
Taeniopteryx maura	11	1,14(91)	2-4	B,C	1(91)	C	U	U	U
Taeniopteryx metequi	39	1-5,7,10,15(89)	1-5	C(80)	1,2(97)	X	C	C	C
Taeniopteryx parvula	9	1,8,9,13-15	2-6+	C(89)	1,2,3	U	U	U	C
Zealeuctra cherokee	15	1(93)	1,2(87)	A,B	1(93)		C	U	
Zealeuctra claasseni	102	1-11,13-15	1-4	A,B,C,D	1,2(97)	U	C	C	C
Zealeuctra fraxina	1	11	3	C	2	U			
Zealeuctra narfi	27	1-3,5,15(85)	1-3	A,B(86)	1,2(92)	X	C	C	C
Zealeuctra wachita	3	1	1,2	A,B,C	1		U		
Zealeuctra warreni	33	1-5,7,14	1-4	A,B,C,D	1,2	U	C	C	U

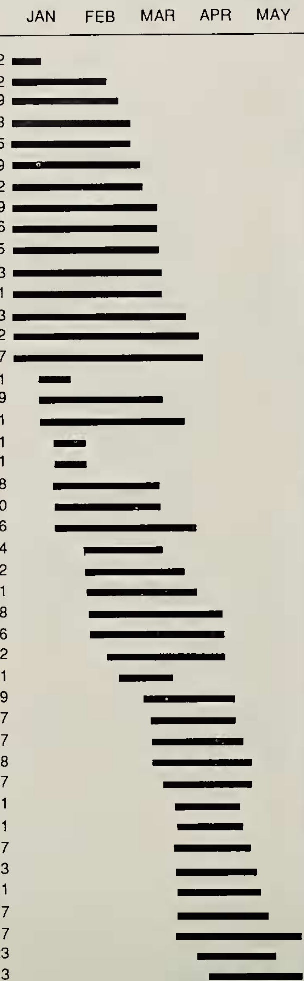
SUBREGIONS: Refer to Fig. 2.
ORDER: Stream orders 1-6+
PERMANENCE: A = Dry stream bed for part of year
B = Intermittent, pools with no flowing water for part of year
C = Permanently flowing the entire year
D = Permanently flowing with significant underground spring source
VEGETATION: 1 = Upland Pine
2 = Upland Hardwood
3 = Bottomland Hardwood
CLUSTERS (Fig. 5): C = Common
U = Uncommon
X = Present but not typical of this cluster, found in 1-2 relict habitats near borders of adjacent clusters

Table 3. (1-15) Plecoptera species diversity within 15 subregions of the Ozark-Ouachita Mountains, and (A-D) number and percentage of species common with other regions in North America.

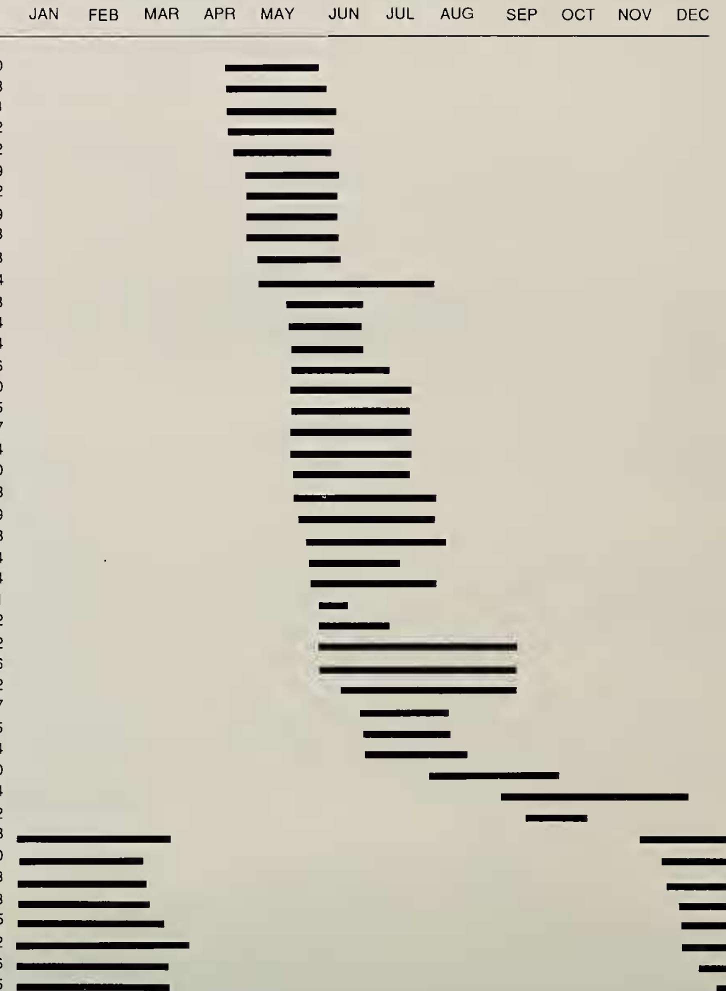
Subregion/N.A. Region (Fig. 2)		Number of Endemics (Total = 25)	Number of species (Total = 88)/% similarity
1	Ouachita Mountains	19	56
2	Boston Mountains	14	44
3	Springfield Plateau	14	43
4	White River Hills	12	40
5	Central Plateau	11	50
6	Osage-Gasconade Hills	6	35
7	Curtois Hills	9	47
8	St. Francois Mountains	8	37
9	Missouri River Border	9	37
10	Mississippi River Border	5	33
11	Illinois Ozarks	0	26
12	Crowley's Ridge	1	8
13	Mississippi Alluvial Plain	3	17
14	Gulf Coastal Plain	10	39
15	Arkansas River Valley	12	40
A	Northern U.S. and Canada (Michigan, Minnesota, Wisconsin, Central and Eastern Provinces		36 (41%)
B	Southern U.S. (Texas, Louisiana, southeastern States)		25(28%)
C	Eastern U.S. (Appalachian Mountains, Northeatern States)		49(56%)
D	Western U.S. and Canada (Rocky Mountains, western provinces)		7(8%)

Table 4. Ozark-Ouachita Plecoptera emergence chart, and total number of collection records for each species (N).

Species	N
Allocapnia oribata	2
Allocapnia ozarkana	2
Allocapnia sandersoni	9
Paracapnia angulata	18
Allocapnia malverna	35
Taeniopteryx parvula	9
Strophopteryx arkansae	42
Allocapnia jeanae	9
Allocapnia pygmaea	6
Zealeuctra cherokee	15
Zealeuctra wachita	3
Taeniopteryx maura	11
Allocapnia vivipara	53
Zealeuctra claasseni	102
Zealeuctra narfi	27
Allocapnia warreni	1
Taeniopteryx metequi	39
Allocapnia smithi	1
Shipsa rotunda	1
Taeniopteryx lonicera	1
Prostoia completa	88
Strophopteryx fasciata	130
Strophopteryx cucullata	96
Prostoia similis	4
Helopicus nalatus	32
Taeniopteryx lita	11
Clioperla clio	258
Hydroperla crosbyi	96
Hydroperla fugitans	2
Zealeuctra fraxina	1
Isoperla coushatta	19
Isoperla mohri	77
Isoperla signata	17
Isoperla burksi	18
Perlinella drymo	57
Nemocapnia carolina	1
Isoperla szczytkoi	1
Pteronarcys pictetii	37
Amphinemura nigritta	3
Isoperla namata	121
Isoperla ouachita	167
Amphinemura delosa	97
Isoperla decepta	23
Isoperla dicala	13



Species	N
Paranetina media	20
Haplopera brevis	88
Alloperla caudata	33
Alloperla ouachita	2
Alloperla hamata	2
Isoperla bilineata	9
Perlesta fusca	22
Paragnetina kansensis	9
Perlesta browni	18
Agnetina capitata	13
Neoperla falayah	64
Leuctra rickeri	3
Alloperla caddo	4
Perlesta baumanni	4
Perlesta cinctipes	26
Acroneuria evoluta	140
Acroneuria filicis	15
Acroneuria internata	17
Acroneuria perplexa	44
Acroneuria mela	10
Perlinella ephyre	48
Perlesta decipiens	119
Acroneuria abnormis	3
Attaneuria ruralis	4
Neoperla robisoni	24
Alloperla leonarda	1
Acroneuria ozarkensis	2
Neoperla harpi	42
Agnetina flavescens	56
Neoperla osage	42
Neoperla carlsoni	7
Neoperla choctaw	15
Perlesta shubuta	14
Neoperla catharae	20
Leuctra tenuis	34
Leuctra paleo	2
Zealeuctra warreni	33
Allocapnia peltoides	10
Allocapnia forbesi	3
Allocapnia mystica	53
Allocapnia rickeri	145
Allocapnia mohri	102
Allocapnia granulata	116
Taeniopteryx burksi	105



the regional endemics, six of which were found in no other subregion (Table 3). The Appalachian Mountains and northeastern states contain the greatest degree of similarity to the region (56 %), and known distribution ranges for only seven species extend into the Rocky Mountains of western North America.

Included in the keys and accounts below are three newly discovered species, and new characters and illustrations within groups that were previously poorly known. The species accounts contain descriptions for the three new species, allotype descriptions and designations for *Alloperla ouachita* and *Zealeuctra wachita*, and 12 new nymph descriptions. Keys reflect current knowledge based on nymphal rearing. Color patterns of some species are variable, and collections of large numbers are helpful in their verification. Of the characters used in key couplets (Figs. 6-464), the first character listed in each couplet is considered the most reliable for specimens collected within the region.

Species accounts below consist of a brief synonymy including only name changes and their references. Collection data and plotted distributions are given in two different ways: 1) specific localities and actual numbers of specimens reared or field collected (M=male, F=female) are listed for less common species, and their distributions are plotted on regional maps (Figs. 465-469), and 2) watershed numbers (Table 1) are listed for common species.

Key to the Families of Ozark-Ouachita Plecoptera

Males and Females

1. Paraglossae and glossae of about equal length (Fig. 26) 2
   Paraglossae longer than glossae (Fig. 25) 6
2. Gill remnants on sides of thorax and abdominal segments 1-2 (Fig. 21) .... **Pteronarcyidae**
   Gill remnants absent from abdominal segments 1-2, but sometimes present elsewhere (Fig. 17, 18) 3
3. Second tarsal segment subequal to first (Fig. 34) .... **Taeniopterygidae**
   Second tarsal segment shorter than first (Fig 32, 33) 4
4. Cerci multisegmented (Figs. 69-81); vein 2A of forewing unforked .... **Capniidae**
   Cerci of one segment, often globular (Figs. 107-111, 138-143); vein 2A in forewing forked (Figs. 6, 10, 14) 5
5. Wings folded flat at rest; forewing with vein in costal space beyond cord (Fig. 6) .... **Nemouridae**
   Wings rolled at rest, covering sides and back of abdomen; forewing without vein in costal space beyond cord (Fig. 14) .... **Leuctridae**
6. Gill remnants on side of thorax (Fig. 17); cubito-anal crossvein in forewing set at anal cell or away from it by a distance less than its length (not reliable in some *Isoperla*, *Clioperla*, and *Perlesta*) (Figs. 8, 12) .... **Perlidae**
   Gill remnants absent from thorax; cubito-anal crossvein removed from anal cell by a distance equal to or greater than its length (Figs. 9, 10) 7
7. Vein 2A of forewing forked beyond anal cell (Fig. 10); body yellow or green in life, (pale in alcohol), wings clear .... **Chloroperlidae**
   Vein 2A of forewing leaves anal cell as 2 separate veins (Fig. 9); body color in life variable, most species with amber to dark wings .... **Perlodidae**

Nymphs

1. Paraglossae and glossae of about equal length (Fig. 26) 2
   Paraglossae longer than glossae (Fig. 25) 6
2. Branched gills on both thorax and abdominal segments 1-2 (Fig. 462) .... **Pteronarcyidae**
   No branched gills on abdominal segments 1-2, but sometimes present elsewhere (Figs. 16, 19, 27) 3
3. Second tarsal segment subequal to first (Fig. 34) .... **Taeniopterygidae**
   Second tarsal segment shorter than first (Figs. 32, 33) 4
4. Wing pads strongly divergent from median body axis (Figs. 177-184); body short, hind legs when extended, reach tip of abdomen .... **Nemouridae**
   Wing pads nearly parallel to median body axis (Fig. 43); body elongate, hind legs when extended do not reach tip of abdomen 5
5. Setae absent, or sparse, on posterior margin of abdominal terga; distance between tips of front wing pads greater than distance between tips of hind wing pads (Fig. 42); membranous pleural fold reaches from first abdominal segment to, at most, the 7th segment (Figs. 36, 37) .... **Leuctridae**
   Setae present on posterior margin of abdominal terga; distance between tips of front wing pads about equal to distance between tips of hind wing pads (Figs. 43, 48); membranous pleural fold reaches to abdominal segment 9 (Fig. 35) .... **Capniidae**
6. Highly branched gills on sides of thorax (Fig. 16) .... **Perlidae**
   Branched gills absent from thorax 7
7. Length of cerci 3/4 or less than abdominal length; pigment contrast weak or absent (Figs. 205-208) .... **Chloroperlidae**
   Length of cerci as long or longer than abdomen; pigment contrast present .... **Perlodidae**

Family Capniidae

This is the best represented family of "winter stoneflies" in the region, with 17 species. The small, black adults were common on bridges, and often were found crawling on snow and ice. Males of all but one species of *Allocapnia* Claassen are brachypterous, but both sexes of the genus were observed gliding for short distances. Unlike Nemouridae and Leuctridae, the adult cerci have several segments, and 2A of the forewing is unforked. Nymphs differ from those of Leuctridae in two ways: 1) the distance between the tips of the front wingpads is subequal to that of the hind wingpads (Fig. 43), and 2) the abdominal pleural fold reaches segment 9 (Fig. 35). Searching bridges, emergent leaves, and debris is effective for collecting adults. The herbivorous nymphs skeletonized pieces of conditioned leaf material added to rearing chambers. Adult *Allocapnia* were apparently attracted to vertical surfaces, and congregated on concrete bridge pillars during warm afternoons. When numerous, males appeared to defend territories, by sparring with antennae. The less active females were found in more secretive places such as crevices and under bridge railings. Ross and Ricker (1971) provided keys to *Allocapnia* adults of eastern North America. The key below includes the recently described *Allocapnia oribata* Poulton and Stewart (1987), and females of some species not previously separated. Except for male nymphs of *Allocapnia vivipara* (Claassen), which lack wing pads, and the relatively large size of *Allocapnia sandersoni* Ricker nymphs, the immature stages of regional *Allocapnia* are currently inseparable.

Key to Genera and Species of Capniidae

Males and Females

1. Males 2
   Females 18
2. Wings brachypterous or reduced to small vestiges .... ***Allocapnia*** **Claassen** 4
   Wings long, reaching tip of abdomen or beyond 3
3. A1 of forewing sharply bent beyond anal cell (Fig. 15); epiproct straight, apex blunt (Fig. 55); cerci with fewer than 11 segments .... ***Nemocapnia carolina*** Banks
   A1 of forewing not sharply bent beyond anal cell; outer margin of epiproct curved, apex sharply pointed (Figs. 51, 52); cerci with 12 or more segments .... ***Paracapnia angulata*** Hanson
4. Wings reduced to small vestiges (Fig. 46) .... ***A. vivipara*** (Claassen)
   Wings extend to middle abdominal segments 5
5. Raised sclerotized process present on tergum 7 and tergum 8 (Figs. 61, 69) 6
   Raised process present on tergum 8 only (Figs. 56-59,73- 75); tergum 7 with, at most, a small hump (Figs. 71, 72) 8
6. Apical section of epiproct upper limb as long or longer than basal section; tergum 7 process a low, unnotched shelf .... ***A. smithi*** Ross and Ricker
   Apical section of epiproct upper limb much shorter than basal section (Fig. 69) 7
7. Tergum 7 process with a small median notch (Fig. 87) .... ***A. ozarkana*** Ross
   Tergum 7 process cone-shaped, without notch .... ***A. forbesi*** Frison
8. Tergum 8 process notched or indented (Figs. 83, 84, 88, 90, 93-95) 9
   Tergum 8 process entire (Figs. 82, 85, 89, 92) 16
9. Apical section of epiproct upper limb shorter than basal section (Figs. 73, 74, 80) 10
   Apical section of epiproct upper limb as long or longer than basal section (Figs. 75-78, 81) 12
10. Tergum 8 process divided into 2 widely separated knobs (Figs. 57, 88) .... ***A. rickeri*** Frison
    Tergum 8 process with narrower notch (Figs. 94, 95) 11
11. Apical section of epiproct upper limb globular, widened apically (Fig. 73) .... ***A. sandersoni*** Ricker
    Apical section of epiproct upper limb elongate, slender apically (Fig. 80) .... ***A. jeanae*** Ross
12. Tergum 8 process without setose knobs along posterior margin (Figs. 59, 60), or if knobs present, upper limb of epiproct thin, blade-like (Fig. 81) 13
    Tergum 8 process with setose knobs present (Figs. 62, 68, 72, 78); upper limb of epiproct swollen apically 15
13. Upper limb of epiproct thin, blade-like (Fig. 81) .... ***A. warreni*** Ross and Yamamoto
    Upper limb of epiproct swollen apically (Figs. 75, 77) 14
14. Apex of epiproct upper limb pointed in dorsal aspect (Fig. 59); notch of tergum 8 process large (Fig. 83) ... ***A. pygmaea*** (Burmeister)
    Apex of epiproct upper limb rounded in dorsal aspect (Fig. 60); notch of tergum 8 process small (Fig. 84) .... ***A. mystica*** Frison
15. Apex of epiproct upper limb rounded; anterior corners of tergum 8 process angulate (Fig. 72) .... ***A. peltoides*** Ross and Ricker
    Apex of epiproct upper limb moderately pointed; anterior corners of tergum 8 process rounded (Fig. 78) .... ***A. granulata*** (Claassen)
16. Upper limb of epiproct thin, blade-like (Fig. 70) .... ***A. mohri*** Ross and Ricker
    Upper limb of epiproct swollen apically (Figs. 71, 76) 17
17. Tergum 8 process wide, and cone-shaped in posterior aspect (Figs. 58, 92) .... ***A. oribata*** Poulton and Stewart
    Tergum 8 process narrow, and rounded or flat in posterior aspect (Figs. 63, 85) .... ***A. malverna*** Ross

18. A1 of forewing sharply bent beyond anal cell (Fig. 15); cerci with fewer than 11 segments............ ***Nemocapnia carolina*** Banks
A1 of forewing straight or slightly sinuate; cerci with more than 12 segments.. **19**
19. Anal lobe of hind wing noticably smaller than rest of wing (Fig. 11); anterior margin of sternum 8 without lateral extensions of pleural membranes (Fig. 53).. ***Paracapnia angulata*** Hanson
Anal lobe of hind wing subequal to rest of wing (Fig. 13); anterior margin of sternum 8 with lateral notches, sometimes extending to posterior margin and separating sterna from pleura (Figs. 96-106) .... ***Allocapnia*** Claassen **20**
20. Sternum 7 and 8 fused (Figs. 96, 97, 103, 105) (some overlap between sterna may occur)...................................... **21**
Sternum 7 and 8 separated by membrane (Figs. 98, 99, 102, 104, 106)... **25**
21. Tergum 8 with little or no membranous areas; posterior margin of sternum 8 straight, with a rounded flap positioned anterior to it (Fig. 97).. ***A. vivipara*** (Claassen)
Tergum 8 with wide membranous area; posterior margin of sternum 8 at least slightly rounded (Fig. 105), or if straight, rounded flap absent (Fig. 100), or overlapping posterior margin (Fig. 103)... **22**
22. Posterior margin of sternum 8 with a wide flap having rounded corners, indented in lateral aspect (Fig. 105), or flexed under margin of sternum 7.. ***A. pygmaea*** (Burmeister)
Posterior margin of sternum 8 with, at most, a narrow flap (Fig. 96), and not indented (Figs. 100, 103)......................... **23**
23. Sternum 8 flap evenly rounded (Fig. 103); large species, extended body length greater than 7mm........... ***A. sandersoni*** Ricker
Sternum 8 flap truncate (Figs. 96, 100); smaller species, extended body length 7mm or less...................................... **24**
24. Sternum 8 flap extended, not continuous with posterior margin (Fig. 96); connection between sternum 7 and 8 narrow (Fig. 96)...... .... ***A. jeanae*** Ross
Sternum 8 flap not extended, nearly continuous with posterior margin (Fig. 100); connection between sternum 7 and 8 wide (Fig. 100) .... ***A. rickeri*** Frison
25. Sternum 8 flap saggitate, and surrounded by membranous areas (Figs. 101, 106)... **26**
Sternum 8 flap not saggitate, posterior margin entire and/or without adjacent membranous areas (Figs. 99, 102, 104)........... **27**
26. Anterior margin of sternum 8 with an evenly rounded, concave indentation; saggitate flap usually wider than long (Fig. 106)...... .... ***A. granulata*** (Claassen)
Anterior margin of sternum 8 without concave indentation, or not evenly rounded (Fig. 101); saggitate flap about as wide as long (Fig. 101).. ***A. peltoides*** Ross and Ricker
27. Sternum 8 flap extends beyond its posterior margin (see Ross & Ricker 1971).. **28**
Posterior margin of sternum 8 either sinuate (Figs. 99, 102, 104) or flap does not extend beyond posterior margin (Fig. 98)....... **29**
28. Sternum 8 flap truncate; tergum 8 with wide membranous area.............................. ***A. smithi*** Ross and Ricker
Sternum 8 flap rounded; tergum 8 with membranous area narrow or absent.................................... ***A. forbesi*** Frison
29. Sternum 8 with 2 circular areas lateral to median flap (Fig. 98).. ***A. ozarkana*** Ross
Sternum 8 without circular areas; posterior margin of sternum 8 sinuate (Figs. 99, 102, 104)................................ **30**
30. Posterior margin of sternum 8 indented (Fig. 104).. ***A. malverna*** Ross
Posterior margin of sternum 8 not indented (Figs. 99, 102)... **31**
31. Posterior margin of sternum 8 continuous and sinuate, without contrasting pigment (Fig. 102)........... ***A. mohri*** Ross and Ricker
Posterior margin of sternum 8 discontinuous, and slightly broken along lateral margins of median hump; pigmentation adjacent to medium hump pale (Fig. 99)... ***A. mystica*** Frison

Nymphs

1. Cercal segments with many fine hairs forming a fringe (Fig. 49) .... ***Nemocapnia carolina*** Banks
Cercal segments with hairs restricted to whorls, not forming a fringe (Fig. 50).. **2**
2. Abdominal terga and their posterior margins with numerous hairs (Fig. 39); front and hind wing pads similar in shape, outer margin of hind wing pads not divergent (Fig. 48).. ***Paracapnia angulata*** Hanson
Abdominal terga and their posterior margins with at most short bristles (Fig. 38); hind wing pads wider at tip than front wing pads, and with outer margin divergent (Fig. 43)... ***Allocapnia*** Claassen

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Allocapnia forbesi Frison

Allocapnia forbesi Frison (1929).

Type locality.— Illinois, Pope County, Dixon Springs.
Regional distribution.— IL: Alexander Co., New Columbia; Pope Co., Dixon Springs, Golconda, Herod; Union Co., Cobden.

Discussion.— This species was reported by Frison (1929) in the southern Illinois Ozarks. It is distinguished from other *Allocapnia* by the cone-shaped process on the male tergum 7. Frison (1935) reported a variant of this species with a similar process on tergum 6. No recent collections are available from the region. The Illinois Ozarks probably represents the western edge of its range, where it was collected in intermittent habitats from early December through early March (Ross and Ricker 1971).

Allocapnia granulata (Claassen)

Figs. 13, 38, 43, 68, 78, 90, 106

Capnella granulata Claassen (1924).
Allocapnia granulata: Frison (1929, 1935).

Type locality.— New York, Johnstown.
Regional distribution.— Watersheds 1-5, 9, 13, 14,

17, 19, 22, 24-29, 31-33, 36-42, 46-49, 52, 53, 56, 57, 60, 61, 65, 67, 71-77, 79-82, 86-92, 95-97, 100-104, 106-123, 125 (Table 1).

Dicussion.— Males of this species are distinguished by the wedge-shaped process and setose knobs of tergum 8 (Fig. 68). In addition to Illinois localities (Frison 1929), it was reported from Oklahoma (Ross and Yamamoto 1967). It is the only *Allocapnia* distributed as far west as the Arbuckle and Wichita Mountains of southern Oklahoma (Ross and Ricker 1971), and north central Texas (Szczytko and Stewart 1977). It is widespread in the region, and as stated by Ross and Ricker (1971), is common in large rivers (74% from permanent streams, Table 2) with slower gradients. It was often collected up to 1 km from moving water, from bridges over lowland streams with large pools. In small, organically enriched creeks in the Missouri River border subregion, it often co-occurrs with *A. vivipara*. These occurrences suggest a wide tolerance to a variety of conditions. Its low frequency in small, high elevation creeks in mountainous areas suggest an inability to compete with other species common in these habitats. Emergence occurs from December to early March.

Allocapnia jeanae Ross

Figs. 67, 80, 95, 96

Allocapnia jeanae Ross (1964).

Type locality.— Arkansas, Washington County, White River,Winslow.

Regional distribution.—Watersheds 7, 9, 10, 21, 23, 25, 28, 34, 36, 65, 81 (Table 1).

Discussion.— Males of this species have a relatively long epiproct upper limb (Fig. 80), and females resemble those of *A. rickeri* and *A. sandersoni*, except for the truncate flap extending from sternum 8 (Fig. 100). In addition to records from northwestern Arkansas (Ross and Ricker 1971), Stewart et al. (1974) reported it from Oklahoma, and our collections include one southwestern Missouri locality and several records from the Ouachita Mountains. Although it was not collected in abundance, it is endemic to the region, occurring in intermittent first and second order streams, or those that dry up during summer months (Table 2). Adults were collected from January through mid March.

Allocapnia malverna Ross

Figs. 63, 76, 85, 104

Allocapnia malverna Ross (1964).

Type locality.— Arkansas, Hot Springs County, Malvern.

Regional distribution.— Watersheds 6, 11, 12, 14-16, 29, 30, 39, 50, 51, 57-59, 62-64, 69 (Table 1).

Discussion.— This species resembles *A. mohri*, but the male epiproct upper limb is broader (Fig. 76), and the female has an indentation on sternum 8 (Fig. 104). Since the original description (Ross 1964), records from Oklahoma (Stark and Stewart 1973a), Texas, (Szczytko and Stewart 1977), and Louisiana (Stewart et al. 1976) have been reported. Our collections include one record from the lower White River Valley, but 97% were from the Gulf Coastal Plain, primarily in cleaner first and second order intermittent streams (Table 2) with sand or gravel substrates. Emergence occurs in January & February.

Allocapnia mohri Ross and Ricker

Figs. 56, 70, 82, 102

Allocapnia mohri Ross and Ricker (1964).

Type locality.— Oklahoma, Leflore County, Summitt.

Regional distribution.—Watersheds 1, 2, 5, 7-9, 13, 18, 20, 21, 23, 25-28, 32-37, 40-45, 48, 49, 52-57, 59, 60, 65, 68, 69, 71-82, 84, 87-90, 96, 98, 99, 107, 108, 114, 116, 118, 120, 122, 123 (Table 1).

Discussion.— Males of this species can be separated from *A. malverna* by the thin, blade-like tip of the epiproct upper limb (Fig. 70). Females are not reliably separated from those of *A. malverna* and *A. mystica*, but sternum 8 of *A. mohri* is usually sinuate and uniformly pigmented (Fig. 102). Based on distributions given by Ross and Ricker (1971), and our own records, it is the most common and widespread *Allocapnia* endemic to the region. It occurs in mountainous subregions, and is common in intermittent streams. Emergence begins in December, and gravid females were collected as late as early April.

Allocapnia mystica Frison

Figs. 60, 75, 84, 99

Allocapnia mystica Frison (1929).

Type locality.— Illinois, Salt Fork River, Oakwood.

Regional distribution.— Watersheds 2, 32, 38, 41, 46, 47, 52, 53, 57, 67, 68, 70, 72, 85, 86, 91, 95, 96, 105-108, 113, 114, 118, 120-122, 125, 126 (Table 1).

Discussion.— Males are distinguished by the short, spatulate epiproct upper limb, and the narrow notch of the tergum 8 process (Figs. 75, 84). Females are not reliably separated from those of *A. mohri*, but the posterior margin of sternum 8 is not uniformly pigmented as is typical for *A. mohri* (Fig. 99). This species occurs in

Arkansas and Missouri (Ross and Ricker 1971), and it was most common in the Central Plateau, White River, and Illinois Ozark subregions. It is the only *Allocapnia* known from Crowley's Ridge, however males of these populations differed slightly in having a shorter tip of the epiproct upper limb. Its distribution is "hourglass" shaped, with the Illinois Ozarks connecting regional populations and those in the Appalachian Mountains. It was common at hilly, upland sites, and emergence occurs from December to early March.

Allocapnia oribata Poulton and Stewart
Figs. 58, 71, 92

Allocapnia oribata Poulton and Stewart (1987).

Type locality.— Arkansas, Searcy County, Middle Fork Little Red River, Shirley.

Regional distribution.— AR: Searcy Co., M. Fk. L. Red R., Hwy 65 @ Shirley, 6-I-85, 3M, BCP; Van Buren Co., Archey Cr., Hwy 254, 12.1 km NE Rupert, 6-I-85, 1M, BCP.

Discussion.— This regional endemic species is distinguished from other *Allocapnia* by the wide unnotched elevated process of male tergum 8. The female is unknown but male characteristics suggest it is a member of the *Allocapnia recta* (Claassen) group (Ross and Ricker 1971). This species is known only from two, 4th order permanent streams (Poulton and Stewart 1987). Emergence occurs in early January.

Allocapnia ozarkana Ross
Figs. 61, 69, 86, 87, 98

Allocapnia ozarkana Ross (1964).

Type locality.— Arkansas, Madison County, Cannon Creek.

Regional distribution.— AR: Johnson Co., Big Minnow Cr., Hwy 123, 5.5 km W Hagarville, 7-I-85, 1M, BCP; Dallas Co., Trib. Moro Cr., Hwy 48, 3 mi E Tulip., 4-II-84, 2M, 9F, BCP; six plotted localities in northern Arkansas (Ross and Ricker 1971).

Discussion.— This regional endemic species is separated from other *Allocapnia* by the notched process on male tergum 7 (Fig. 61). It has not been collected in large numbers, and is apparently rare (Ross and Ricker 1971). A relict population was discovered from the northern Gulf Coastal Plain during this study (Trib. of Moro Cr., listed above), but other collections were from intermittent streams in the Boston Mountains and the White River drainage. Emergence occurs in January and February.

Allocapnia peltoides Ross and Ricker
Figs. 62, 72, 93, 101

Allocapnia peltoides Ross and Ricker (1964).

Type locality.— Oklahoma, Leflore County, Polk Creek, Poteau.

Regional distribution.— AR: Polk Co., Rock Cr. Hwy 271, 4.4 km SW Mena, 26-XI-83, 1M, 6F, 20 n, BCP; Scott Co., Big Cedar Cr., Hwy 28, 9-I-85, 1M, BCP; Mill Cr. (Ross and Ricker 1971); Sebastian Co., creek 11 km SW Hartford, 17-II-85, 1M, 2F, BCP. OK: Haskell Co., 8.8 km S Lewisville, 10-II-61, 1M, H. H. Ross & J. A. Ross; Leflore Co., Hwy 270, Page, 4-II-79, 16M, 8F, BPS; Pushmataha Co., Hardy Cr., 19.8 km S Clayton, 1M, BPS.

Discussion.— This regional endemic species is similar to *A. granulata* in the wedge-shaped process on male tergum 8 (Figs. 62, 72), and a sagitate flap on female sternum 8 (Fig. 101). The upper limb of the epiproct is rounded at the tip rather than pointed as in *A. granulata*. The rarity of *A. peltoides* was noted by Stark and Stewart (1973a) who listed one locality from Oklahoma. Additional localities listed above confirm its restriction to the Ouachita subregion. All known localities are small to medium-sized intermittent streams in upland pine. Emergence occurs from late November through February, which is earlier than for other winter species.

Allocapnia pygmaea (Burmeister)
Figs. 59, 77, 83, 105

Semblis pygmaea Burmeister (1839).
Allocapnia pygmaea: Ross and Ricker (1971).

Type locality.— Canada, Ontario.

Regional distribution.— MO: Miller Co., Bagnell, 25-III-61, 2M, H.H. Ross and L.J. Stannard; Blue Spring Cr., Hwy 54, 2 km S Bagnell, 16-III-86, 1M, BCP; Reynolds Co., Trib. Logan Cr., Hwy Y @ Ellington, 29-I-87, 1 M, BCP; Shannon Co., Round Spring, date & collector unknown; Sinking Cr., Hwy 19, 11 km S Timber, 29-I-87, 1M, BCP. Five additional Missouri records given by county (Ross et al. 1967): Franklin Co., Maries Co., Phelps Co., Reynolds Co., Washington Co.

Discussion.— This species is similar to *A. mystica*, but the notch of the male tergum 8 is wider, and the upper limb of the epiproct is pointed (Figs. 59, 77, 83). Ross et al. (1967) noted modal variation in the epiproct, with Ozark populations posessing shorter epiproct tips than eastern populations. Missouri populations are disjunct from the northern and eastern portions of its range. Ross et al. (1967) noted *A. pygmaea* as a subboreal species, found only in streams which remain cool throughout the year, and Pugsley and Hynes (1986) found this species to exhibit hyporheic nymphal diapause during summer months. Collections during this study support these works, but it was never collected in large numbers. It is restricted to permanent habitats, and those that recieve flow from underground springs. It is considered a rare and endangered species in Missouri (Wilson 1984), and was collected from late January to mid-March.

Allocapnia rickeri Frison
Figs. 57, 74, 88, 100

Allocapnia rickeri Frison (1942).

Type locality.— Illinois, Pope County, Grand Pierre River, Golconda.

Regional distribution.— Watersheds 1-4, 7-9, 13, 14, 17, 20-23, 25-28, 31, 32, 34-38, 41-46, 48-50, 52-57, 61, 64-69, 71-74, 80, 81, 83-89, 91-94, 96, 97, 99-107, 109-111, 115-125 (Table 1).

Discussion.— Males of this species can be distinguished by the wide, U-shaped notch of tergum 8, which appears as two separate knobs (Fig. 57). It is one of the most common regional species, first reported by Frison (1942) from Illinois, and Ross (1964) and Stewart et al. (1974) from Arkansas, Missouri and Oklahoma. The Ozark-Ouachita region is probably the southwestern limit of its range, where it was found in a variety of stream sizes and in every subregion except Crowley's Ridge. It is common in mountainous areas, and adults occur from December through March.

Allocapnia sandersoni Ricker
Figs. 35, 65, 73, 94, 103

Allocapnia sandersoni Ricker (1952).

Type Locality.— Arkansas, Washington County, Clear Creek, Fayetteville.

Regional distribution.— Watersheds 32, 36, 41, 42, 71, 72, 90, 96, 122 (Table 1).

Discussion.— This species is similar to *A. rickeri*, but the notch of male tergum 8 is smaller. It is the largest regional *Allocapnia*, and adults and mature nymphs are 10 mm or more in length. This regional endemic was reported in Arkansas (Ricker 1952), Missouri (Ross and Ricker 1971) and Oklahoma (Stark and Stewart 1973a). It is most common in 2nd order streams with upland hardwoods in the White River and Springfield Plateau subregions. Adults are present in January and February.

Allocapnia smithi Ross and Ricker

Allocapnia smithi Ross and Ricker (1971)

Type locality.— Kentucky, Butler County, 5.5 km W of South Hill.

Regional distribution.— IL: Pope Co., Lusk Cr., 11 km SE Eddyville, 5-III-58, 3M, H.H. Ross and L.J. Stannard.

Discussion.— This species was collected from a single locality in southern Illinois (Ross and Ricker 1971). Males are distinguished from other *Allocapnia* by the presence of a short, shelf-like tergum 7 process (Ross and Ricker 1971). It is common in Kentucky and northern Alabama, and the Illinois locality listed above probably represents the northwestern limit of its range. No additional specimens were recorded from the region, where it emerges from small, spring-fed streams from mid-December to late March (Ross and Ricker 1971).

Allocapnia vivipara (Claassen)
Figs. 46, 64, 79, 89, 97

Capnella vivipara Claassen (1924).
Allocapnia vivipara: Frison (1929, 1935).

Type locality.— Illinois, Lake Forest.

Regional distribution.— Watersheds 67, 86, 88, 89, 94, 101, 105-108, 110-114, 118, 119, 126 (Table 1).

Discussion.— Males of this species were the only specimens collected during this study with wings reduced to small vestiges (Fig. 46). The epiproct upper limb is similar to *A. rickeri* and *A. sandersoni*, and the female resembles *A. rickeri* except tergum 8 has little or no membranous area. Frison (1942) reported it from Illinois and Missouri, and Stark and Stewart (1973a) and Stewart and Huggins (1977) reported it from Oklahoma and Kansas, respectively. Our record from Lawrence Co., Arkansas (Little Cypress Creek, Hwy 25) is the first for this state, and extends the known range further south in the Mississippi Valley. This lowland species was most commonly found in Mississippi-Missouri River border subregions and the Illinois Ozarks (Table 2), often from streams with organic enrichment. Adults are present from January through March.

Allocapnia warreni Ross and Yamamoto
Figs. 66, 81

Allocapnia warreni Ross and Yamamoto (1966).

Type locality.— Arkansas, Washington County, Clear Creek.

Regional distribution.— AR: Washington Co., Clear Cr., 29-I-year unknown, 1M, H.H. Ross.

Discussion.— The male tergum 8 process of this species resembles that of *A. granulata* (Fig. 66), but the epiproct upper limb is narrower and resembles *A. mohri* (Fig. 81). Repeated collections from the type locality failed to yield any specimens, and the female remains unknown. It is considered a sister species of *A. granulata* (Ross and Ricker 1971). The type locality has undergone extensive deterioration due to agricultural pollution and siltation, which may have eliminated the population.

Nemocapnia carolina Banks

Figs. 15, 49, 54, 55

Nemocapnia carolina Banks (1938).

Type locality.— North Carolina, Morgantown.

Regional distribution.— AR: Saline Co., Salt Cr., Benton, 15-IV-39, 1M, H.H. & J.A. Ross.

Discussion.— This species is similar to *Paracapnia angulata*, but the forewing has a sinuate A1 (Fig. 15), and the cerci have fewer than 11 segments. The bluntly pointed epiproct has no lower limb as in *Allocapnia*, and nymphal cerci have a fringe of fine hairs (Figs. 49, 55). The specimen collected in 1939 listed above was examined from a loan of INHS material, and confirmed to be this species. This is the only known record west of the Mississippi River, and four additional collections from this second order permanent stream have not produced additional specimens. Hitchcock (1974) noted a spring emergence for this species, suggesting the presence of adults later than other regional Capniidae.

Paracapnia angulata Hanson

Figs. 11, 39, 48, 50-53

Paracapnia angulata Hanson (1961).

Type locality.— Massachusetts, Pelham.

Regional distribution.— Watersheds 4, 17, 25, 28, 36, 38, 49, 56, 68, 83, 85, 87, 96, 104, 120, 124, 125 (Table 1).

Discussion.— The lower limb of the epiproct found in all other *Allocapnia* is absent in this species (Fig. 52), and the wings are of normal length. Frison (1942) reported it from Illinois as *Capnia opis* (Newman), and Hanson (1946) recognized *Paracapnia* as a separate genus. Specimens examined at the INHS collected from Arkansas and Missouri after 1946 were labeled *Paracapnia opis* (Newman). Later, Hanson (1961) recognized *P. angulata* as a separate species, and Ernst and Stewart (1985b) recently reported it from Oklahoma. Our records from the Ouachita Mountains probably represent the southwestern limit of its distribution. Its presence is an indicator of permanently flowing streams, and was collected from mountainous subregions where springs are common (Table 2). Adults frequent emergent leafpacks and stream side vegetation in January and Febuary.

Family Leuctridae

This family of small, thin, black stoneflies has nine regional species, many of which are part of the "winter stonefly" fauna. Unlike Capniidae, all regional species have full-length wings, which are often rolled around the sides of the abdomen. Nymphs have a greater distance between the tips of the front wingpads than of the hind wingpads. Adults were collected by searching bridges or riparian vegetation. Nymphs are herbivore-detrivores, occupying leaf packs and debris along stream margins and habitats with slower currents. Ricker and Ross (1969) and Hitchcock (1974) provided descriptions and keys to *Zealeuctra* Ricker and *Leuctra* Stevens, respectively, but four of nine regional species were not known at that time. Female specimens of *Z. fraxina* were not available for illustration, and is omitted from the key. Pre-emergent nymphs can be identified with the key below, if adult structures can be seen through the cuticle.

Key to Genera and Species of Leuctridae

Males and Females

1. Male tergum 9 deeply cleft (Figs. 107-111); female sternum 8 with a pair of accessory sclerites, sometimes hidden under subgenital plate (Figs. 130-134) .... ***Zealeuctra*** Ricker **2**
   Male tergum 9 entire (Figs. 123-125); female sternum 8 without accessory sclerites (Figs. 135-137) .... ***Leuctra*** Stevens **8**
2. Males **3**
   Females **13**
3. Epiproct with 2 prominent spines (Fig. 119) or an accessory cusp behind largest spine (Fig. 118) **4**
   Epiproct with one spine and, at most, ventral serrations (Figs. 112, 114, 116, 121) **5**
4. Epiproct with 2 prominent spines, the smaller one ventral (Fig. 119) .... ***Z. warreni*** Ricker and Ross
   Epiproct with small accessory cusp behind the primary spine (Fig. 118) .... ***Z. fraxina*** Ricker and Ross
5. Origin of terminal epiproct spine anterior to bulbous posterior portion (Fig. 112); tergum 9 cleft narrowed anteriorly, "V"-shaped, and with sclerotized margin narrow (Fig. 107) .... ***Z. claasseni*** (Frison)
   Hind portion of epiproct not bulbous, generally following curvature of spine (Figs. 114, 116, 121); tergum 9 cleft not narrowed anteriorly, "U"-shaped, with sclerotized margin wide (Figs. 108, 110, 111) **6**

6. A pair of knobs present on anterior margin of the tergum 9 cleft, or if these absent, terminal posterior lobes of cleft single, pointing inward (Fig. 111); cerci truncate in lateral aspect, without dorsal swelling (Fig. 122) .... ***Z. wachita*** Ricker and Ross
   Knobs on anterior margin of tergum 9 cleft absent (serrations may be present); terminal posterior lobes of cleft split into 2 closely set lobes on each side (Figs. 108, 110); cerci with dorsal swelling (Figs. 115, 117).. **7**
7. Terminal posterior lobes of tergum 9 cleft about 2X size of adjacent, inner lobes (Fig. 108); terminal indentation of cerci strongly concave in lateral aspect (Fig. 117)... ***Z. narfi*** Ricker and Ross
   Terminal posterior lobes of tergum 9 cleft 3-4X size of adjacent inner lobes, and barely separated (Fig. 110); terminal indentation of cerci weakly concave in lateral aspect .... ***Z. cherokee*** Stark and Stewart
8. Males.. **9**
   Females **11**
9. Tergum 7 with truncate process extending caudad over tergum 8 (Figs. 124, 128)............................. ***L. tenuis*** (Pictet)
   Tergum 7 with no process (Fig. 123), or with, at most, a small sinuate band of sclerotization, appearing knob-like (Fig. 125) **10**
10. Paraprocts as long or longer than specilla (Figs. 126, 127); specilla with long subterminal spines (Fig. 127)..................... .... ***L. paleo*** Poulton and Stewart, n.sp.
   Paraprocts about 1/2 as long as specilla (Fig. 129); specilla with, at most, short subterminal knobs (Fig. 125)....... ***L. rickeri*** James
11. Subgenital plate notched laterally (Fig. 135)... ***L. tenuis*** (Pictet)
   Subgenital plate entire laterally, or with, at most shallow indentations (Figs. 136, 137).. **12**
12. Small lobe present in terminal notch of subgenital plate (Fig. 136) .... ***L. rickeri*** James
   Small lobe absent from terminal notch of subgenital plate (Fig. 137)........................... ***L. paleo*** Poulton and Stewart, n.sp.
13. Median lobe of sternum 7 absent; sclerites of sternum 8 directed laterad (Fig. 134) .... ***Z. warreni*** Ricker and Ross
   Median lobe present on sternum 7, but often covered by sternum (Figs. 130-133); sclerites of sternum 8 oval or triangular with rounded margins **14**
14. Posterior margin of sternum 7 straight, with terminal lobe located behind the margin or separated from it by membranous areas (Figs. 131, 132)... **15**
   Posterior margin of sternum 7 with notch containing the terminal lobe (Figs. 130, 133)... **16**
15. Terminal lobe evenly rounded, about as long as wide and membranous (Fig. 131) .... ***Z. claasseni*** (Frison)
   Terminal lobe truncate, about twice as wide as long (Fig. 132) .... ***Z. narfi*** Ricker and Ross
16. Notch of sternum 7 deep, containing elongate terminal lobe with adjacent membranous areas (Fig. 133); sclerites of ster num 8 about same size as terminal lobe and somewhat triangular ....***Z. cherokee*** Stark and Stewart
   Notch of sternum 7 shallow, (sometimes appearing deep due to lack of pigmentation surrounding lobe base)(Fig. 130); sclerites of sternum 8 smaller than terminal lobe, and oval .... ***Z. wachita*** Ricker and Ross

Nymphs

1. Membranous pleural fold present on abdominal sterna 1-4 (Fig. 37); abdominal terga with numerous hairs .... ***Leuctra*** Stevens
   Membranous pleural fold present on abdominal sterna 1-6 (Fig. 36); abdominal terga with very few hairs, or naked............... .... ***Zealeuctra*** Ricker

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Leuctra paleo Poulton & Stewart, new species
Figs. 14, 123, 126, 127, 137

Type locality.— Arkansas, Columbia County, Tributary of Smackover Creek, Hwy 98, 8.8 km E McNeil.

Types.—Holotype M, Allotype F, 2 paratype M, and 4 paratype F, (all reared), 2-X-84, BCP. Holotype and allotype in USNM, paratypes in UNT Insect Museum. Additional paratypes: AR: Dallas Co., Browns Cr., Hwy 8, 10 km W Princeton, 3-X-84, reared 2M, 2F, field 2M, 3F, BCP. Paratypes deposited in BCP collection.

MALE: (Figs. 123, 126, 127). Forewing length 7mm, body length 6mm. Color and wing venation simliar to other *Leuctra*. Terga 7 & 8 entire, without projections or lobes. Specilla widest at base, narrowing posteriorly, with long subterminal spine pointing laterally (Fig. 127). Paraprocts as long or longer than specilla (Figs. 123, 126). Vescicle similar to other *Leuctra*.

FEMALE: (Fig. 137). Forewing length 8mm, body length 7mm. Color and wing venation similar to other *Leuctra*. Sternum 8 with shallow notch, apices of lobes evenly and broadly rounded, and darkened.

Etymology.— This species is named for the ancient Paleo Indians who were the first human inhabitants of Arkansas.

Discussion.— Since the description of *Leuctra szczytkoi* Stark and Stewart (1981), no species of *Leuctra* have been described west of the Mississippi River. *Leuctra szczytkoi* and *Leuctra rickeri*, are different in the lengths of the paraprocts, and the specilium spines. All male terga are entire and bear no lobes or projections. This species was collected from clear, sandy substrate, permanent streams in the Gulf Coastal Plain, and emergence occurs in October.

Leuctra rickeri James
Figs. 125, 129, 136

Leuctra rickeri James (1976).

Type locality.— Kentucky, Frenchburg.

Regional distribution.— IL: Pope Co., Gibbons Cr., Herod, 24-V-40, 3 M, 3 F, 7 n, C.O. Mohr. & B.D. Burks;

Lusk Cr., Eddyville, 24-V-40, 2 M, 2 F, C.O. Mohr & B.D. Burks; Union Co., trib. Devils Kitchen Lake, Panthers Den, 28.6 km SE Carbondale, 13-V-76, 4 M, 8 F, W. Brigham & J. Unzicker.

Discussion.— Males of this species lack the posterior tergum 7 process found in *L. tenuis*, and the long paraprocts and specilium spine of *L. paleo*. James (1976) placed this species in the *L. ferruginea* Walker group. Figures 125, 129, and 136 drawn from the Union Co., Illinois specimens above, differ slightly from those of James (1976), in the notch of the female subgenital plate. Since James (1976) recorded southern Illinois specimens as *Leuctra rickeri*, including those previously labeled as *L. ferruginea* at the INHS, these specimens are tentatively placed with *L. rickeri*, pending a revision of this complex. Within the region, it is limited to the Illinois Ozarks, where it emerges in May.

Leuctra tenuis (Pictet)

Figs. 37, 124, 128, 135

Nemoura tenuis Pictet (1841).
Leuctra tenuis: Claassen (1940).

Type locality.— Pennsylvania, Philadelphia.

Regional distribution.—Watersheds 3, 4, 17, 22, 23, 25, 28, 38, 45, 47, 49, 52, 53, 65, 66, 68, 83, 85, 87, 93, 95, 96, 99, 100, 109, 118, 119 (Table 1).

Discussion.— This species is distinguished by the truncate male tergum 7 process, which extends posteriorly over tergum 8 (Fig. 124, 128). Among regional populations, this structure exhibits variability in length and width. This is the most abundant *Leuctra* in the region. It was collected at Greer Spring, Missouri, by Harden and Mickel (1952), and recently from Oklahoma, by Ernst and Stewart (1985b). The Ozark-Ouachita region probably represents the southwestern limit of its range. It is nearly restricted to permanent streams (Table 2), and is especially common in spring streams. Small nymphs appeared in May collections, and were collected from a few limestone streams that became intermittent in late summer. This suggests it may have the ability to emerge earlier or occupy standing pools prior to fall emergence. This species emerges during early and mid summer in Wisconsin, and the upper peninsula of Michigan (BCP, unpublished). Emergence in the Ozark-Ouachita region begins in late August and continues through mid November.

Zealeuctra cherokee Stark and Stewart

Figs. 110, 114, 115, 133

Zealeuctra cherokee Stark and Stewart (1973b).

Type locality.— Oklahoma, Sequoyah County, 4.4 km W Vian.

Regional distribution.— Watersheds 1, 5, 7, 10, 17-19, 33, 37, 56, 71, 73, 78, 81, 90 (Table 1).

Discussion.— This species can be distinguished from other *Zealeuctra* by the wide, horseshoe-shaped cleft of the male tergum 9, which has posterior lobes barely separated from the smaller, inner lobes (Fig. 110). Based on our records, it is restricted to the Ouachita Mountains and Arkansas River Valley. It was collected in first and second order intermittent or dry streams (Table 2), suggesting requirements similar to other *Zealeuctra*. Emergence occurs in January and February.

Zealeuctra claasseni (Frison)

Figs. 36, 42, 107, 112, 113, 131

Leuctra claasseni Frison (1929).
Leuctra (Zealeuctra) claasseni: Ricker (1952).
Zealeuctra claasseni: Ricker & Ross (1969).

Type locality.— Illinois, Pope County, Bushy Fork, Herod.

Regional distribution.— Watersheds 1-5, 7-10, 13, 14, 19-23, 26-28, 31-38, 40-43, 45-48, 52-57, 60, 61, 65, 67-69, 71-74, 76-87, 89, 90, 92, 93, 95-99, 102-105, 107-111, 119-126 (Table 1).

Discussion.— This species is distinguished from other *Zealeuctra* by the bulbous basal portion of the male epiproct, and the rounded fleshy lobe of female sternum 8 (Figs. 112, 131). It has been reported from several localities (Frison 1929, 1935, 1942; Illies 1966; Hitchcock 1974; Stewart et al. 1974), and was the most commonly encountered species of Leuctridae in the region. It is the only regional *Zealeuctra* to be collected as far west as northern Texas (Szczytko and Stewart 1977). Snellen and Stewart (1979a) reported that this species had life cycle flexibility, with extended periods of egg diapause in dry years, and very fast nymphal growth. Only 14% of our collection localities were permanently flowing streams (Table 2), suggesting that an egg diapause was probable. Emergence occurs from January to early April.

Zealeuctra fraxina Ricker and Ross

Fig. 118

Zealeuctra fraxina Ricker and Ross (1969).

Type locality.— Kentucky, Breckenridge County, Hardinsburg.

Regional distribution.— IL: Pope Co., Gibbons Cr., Herod, 6-III-28, 1M, T.H. Frison, H.H. Ross.

Discussion.— Males of this species are distinguished by the subterminal point of the epiproct, located above the main spine (Fig. 118). It is mentioned here because of its close resemblance to *Z. warreni*. The southern

Illinois locality probably represents the western limit of its distribution. Considered rare, its habitat requirements are poorly known, and no recent collection records have been reported from the region. It is known to emerge in early March.

Zealeuctra narfi Ricker & Ross
Figs. 108, 116, 117, 132

Zealeuctra narfi Ricker & Ross (1969).

Type locality.— Wisconsin, Sauk County, Otter Creek.

Regional distribution.— Watersheds 1, 8, 9, 16, 19, 21, 23, 34, 35, 42, 52, 54, 55, 58, 67, 69, 75, 81, 89, 116 (Table 1).

Discussion.— Males of this species differ from *Z. cherokee* in the relative width of the cleft of tergum 9, and the two pairs of posterior lobes (Fig. 108). Ricker and Ross (1969) and Stark and Stewart (1973a) provided many records for Arkansas, Missouri, and Oklahoma. Regional localities probably represent the southern limit of its range, and it occurred most frequently in the Ouachita, Arkansas River Valley, and Boston Mountain subregions. Most collections were from intermittent or dry streams, suggesting an egg diapause like that of *Z. claasseni* in Texas (Snellen and Stewart 1979a). Emergence begins in January and continues to early April.

Zealeuctra warreni Ricker and Ross
Figs. 109, 119, 120, 134

Zealeuctra warreni Ricker and Ross (1969).

Type locality.— Arkansas, Sharp County, Sugar Creek, Hardy.

Regional distribution.— Watersheds 1, 4, 5, 8, 9, 10, 13, 17, 18, 19, 22, 23, 25, 28, 31, 35, 36, 42-45, 49, 52, 55-57, 60, 65, 66, 71, 73, 74, 76, 77, 79-81, 83, 90, 91, 96, 102, 118, 122 (Table 1).

Discussion.— Males are distinguished from other *Zealeuctra* by the 2-spined epiproct (Fig. 119), and females lack a median lobe on sternum 8 (Fig. 134). It most closely resembles *Z. fraxina*. Ricker and Ross (1969) reported it from Arkansas and Oklahoma, and records above include the first known from Missouri. This regional endemic was most commonly collected from mountainous subregions (Table 2). This species is one of the first winter stoneflies to begin emerging in November. Ernst and Stewart (1985b) found females to exhibit greatly extended emergence, from November to mid- March. Our records support this, with males found through early January, and collections through mid-March being dominated by females.

Zealeuctra wachita Ricker and Ross
Figs. 111, 121, 122, 130

Zealeuctra wachita Ricker and Ross (1969).

Type locality.— Arkansas, Polk County, Ouachita River.

Types.— Allotype M, AR: Polk Co., Ouachita R., 5.5 km W Acorn, 23-III-84, BCP. Allotype in USNM.

Regional distribution.— AR: Polk Co., Ouachita R., 5.5 km W Acorn, 23-III-84, 1M, 4F, 16-II-85, 1M, BCP; Scott Co., trib. Johnson Cr., Hwy 71, 8.8 km W Y-City, 9-I-85, 1M, 1F, BCP.

The male is described here for the first time:

MALE: (Figs. 111, 121, 122). Forewing length 6mm, body length 7 mm. Cleft of tergum 9 narrowed anteriorly, with heavily sclerotized inner margin, hind corners each with a single rounded lobe directed inward, and anterior edge with 2 bluntly pointed knobs (Fig. 111). Epiproct with a single long, acutely pointed spine, with a small anterior decline (Fig. 121). Cercal tips heavily sclerotized, the small subterminal hump with dorsal shelf; ventral margin setose (Fig. 122). Vescicle and probe similar to *Z. cherokee*.

Discussion.— Males of this species have a pair of small knobs on the inside margin of the median notch (Fig. 111). The female is difficult to distinguish from *Z. cherokee*, and separation in the key is based on coloration near the lobes of sternum 8. Males and females were correlated from the type locality, and additional specimens were collected from a nearby watershed. Both sites became intermittent during summer months. Emergence occurs during February and March.

Family Taeniopterygidae

This family contains nine regional species of "winter stoneflies". They are larger in size than the Capniidae and Leuctridae, and are usually dark in color. Adults and nymphs are easily separated from other stoneflies because the first and second tarsal segments are subequal in length (Fig. 34). Mature nymphs have divergent wing pads, and were commonly collected from leaf packs and organic debris, or gravel containing high amounts of interstitial organic matter. The submerged, net-like root system remaining from beds of water willow at the margins of riffles provided habitat for *Strophopteryx* Frison nymphs during winter. Adult taeniopterids were commonly collected from bridges and vegetation. Ovipositing females were observed flying over riffles during mid-day when temperatures reached at least 13°C. Nymphs skeletonized pieces of leaf material fed to them during rearing, which supported their classification as herbivore-detritivores. Nymph and adult keys are available for *Taeniopteryx* Pictet (Ricker and Ross 1968;

Harper and Hynes 1971; Fullington and Stewart 1980), and the key below reflects regional variation in this genus. Adult descriptions are available for regional *Strophopteryx* (Ricker and Ross 1975), but the key below is the first for both nymphs and adults of this genus.

Key to Genera and Species of Taeniopterygidae

Males and Females

1. Gill scar present, appearing as membranous hole in coxae (Fig. 18) .... ***Taeniopteryx*** Pictet 2
   No gill scar present on coxae (Fig. 20) .... ***Strophopteryx*** Frison 7
2. Male vescicle present on sternum 9 (Fig. 152); female subgenital plate notch without marginal sclerotized band (Figs. 162, 163) 3
   Male vescicle absent; female subgenital plate notch bordered by sclerotized band (Figs. 164-167) 4
3. Male with femoral spur, its length equal to at least half of femur width (Fig. 172) .... ***T. maura*** (Pictet)
   Male without spur on femur, but small raised knob or swelling may be present (Fig. 171) .... ***T. burksi*** Ricker and Ross
4. Distal portion of male sub-anal lobes broadly rounded (Figs. 154, 155); female subgenital plate notch with wide, U-shaped or sub-rectangular band of sclerotization (Figs. 166, 167) 5
   Distal portion of male sub-anal lobes narrow, curved outward, or club shaped at tip (Figs. 156, 157); female subgenital plate notch with narrow U or V-shaped band of sclerotization (Figs. 164, 165) 6
5. Male cerci long, narrow, curved inward at tip (Fig. 154); sclerotization of female subgenital plate U-shaped, evenly rounded anteriorly (Fig. 166) .... ***T. lonicera*** Ricker and Ross
   Male cerci short, broad, and slightly curved inward at tip (Fig. 155); sclerotization of female subgenital plate sub-rectangular, not evenly rounded anteriorly (Fig. 167) .... ***T. lita*** Frison
6. Tip of male sub-anal lobes globular, club-shaped (Fig. 157); notch of female subgenital plate U-shaped, with median flap wide, truncate (Fig. 165) .... ***T. metequi*** Ricker and Ross
   Male sub-anal lobes narrow, hooked outward apically (Fig. 156); notch of female subgenital plate V-shaped, with median flap narrow, truncate (Fig. 164) .... ***T. parvula*** Banks
7. Male sternum 9 elongate and upturned between cerci (Fig. 159); posterior margin of male tergum 9 with a pair of globular setose bulbs extending caudally (Fig. 158); flap of female sternum 9 truncate at tip (Fig. 170) .... ***S. fasciata*** (Burmeister)
   Male sternum 9 not upturned between cerci; posterior margin of male tergum 9 without globular setose bulbs (Figs. 160, 161); female sternum 9 evenly rounded (Figs. 168, 169) 8
8. Male epiproct tip broad (Fig. 160); basicercal process of male bearing a sharp caudally directed spine (Fig. 160); female abdomen pink or reddish in life, sternum 9 broadly rounded (Fig. 169) .... ***S. cucullata*** Frison
   Male epiproct tip narrow (Fig. 161); basicercal process of male rounded (Fig. 161); rest of female abdomen pigmented darker than sternum 9; tip of sternum 9 narrowly tapered (Fig. 168) .... ***S. arkansae*** Ricker and Ross

Nymphs

1. A single, finger-like gill on each coxa (Fig. 19) .... ***Taeniopteryx*** Pictet 2
   No coxal gills present .... ***Strophopteryx*** Frison 9
2. Mid-dorsal stripe absent or incomplete (Fig. 178) 3
   Mid-dorsal stripe continuous (Figs 177, 179, 180) 4
3. Mid-dorsal stripe most distinct on abdomen; thorax and pronotum concolorous or with pale markings (Fig. 178); area adjacent to eyes as dark as rest of head (Fig. 181) .... ***T. lita*** Frison (in part)
   Mid-dorsal stripe broken throughout its length, weak or entirely absent on abdomen (Fig. 178); area adjacent to eyes paler than rest of head (Fig. 178) .... ***T. parvula*** Banks
4. Pigmentation darkest along border of mid-dorsal stripe, either throughout its length (Fig. 177), or on thorax only (Fig. 179) 5
   Pigmentation along border of mid-dorsal stripe as dark as rest of nymph (Figs. 180, 181) 7
5. Pale area between eyes wider than pronotal portion of mid-dorsal stripe; muscle scars evident (Fig. 179); broad pale ring around each eye (Fig. 179) .... ***T. metequi*** Ricker and Ross (in part)
   Pale area between eyes and pronotal portion of mid-dorsal stripe of same width (Fig. 177); usually no muscle scars visible (Fig. 177); pale ring around eyes narrow or absent 6
6. Developing femoral spur in mature male nymphs visible under exoskeleton (Fig. 175) .... ***T. maura*** (Pictet)
   No femoral spur visible under exoskeleton, at most a raised swelling occurs (Fig. 176) .... ***T. burksi*** Ricker and Ross
7. Head protion of mid-dorsal stripe wider than pronotal portion, with muscle scars visible (Fig. 179); broad pale ring around each eye (Fig. 179) .... ***T. metequi*** Ricker and Ross (in part)
   Head portion of mid-dorsal stripe of same width or narrower than pronotal portion (Figs. 180, 181); pale ring around eyes narrow or absent 8
8. Pale rectangular area between eyes extends laterally beyond ocelli (Fig. 180) .... ***T. lonicera*** Ricker and Ross
   Pale rectangular area between eyes limited to area between lateral ocelli (Fig. 181) .... ***T. lita*** Frison (in part)

9. Abdominal terga banded, anterior margin dark (Fig. 183); wing pads with contrasting blotches, appearing mottled. . . . . *S. fasciata* (Burmeister)
   Abdominal terga not banded (Fig. 182); wing pads with, at most, faint darker areas (Fig. 182). **10**
10. Pale ring surrounding eyes (Fig. 184); spots on abdominal segments large, nymphs pale yellow-orange to sandy brown in life . . . . . . *S. arkansae* Ricker and Ross
   Area surrounding eyes as dark as rest of head (Fig. 182); spots on abdominal segments small, appearing as specks (Fig. 182); nymphs olive green to brown or black in life.. . . . . *S. cucullata* Frison

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Strophopteryx arkansae Ricker and Ross

Figs. 161, 168, 184

Strophopteryx arkansae Ricker and Ross (1975).

Type locality.— Arkansas, Polk County, Two Mile Creek,Hatfield.

Regional distribution.— Watersheds 1, 5, 7, 9, 13, 14, 18, 27, 34, 35, 37, 42-44, 49, 55-57, 61, 71-74, 77, 80, 85, 91, 98, 104 (Table 1).

The first nymphal description is provided here:

NYMPH: (Fig. 184). General color pale yellow, sandy brown, or reddish-orange. Head with pale area around each eye, and rectangular pale areas posterior to lateral ocelli and anterior to median ocellus. Paired spots on abdominal terga and pleura large, abdominal banding or striping absent, blotches on thorax absent. Femora and tibiae with prominent setal fringe along outer margin.

Discussion.— This species differs from *S. cucullata* because it lacks the pointed male basicercal process found in *S. cucullata*, and has a narrower epiproct (Fig. 161). The female sternum 9 is narrower than that of *S. cucullata* (Fig. 168). *S. arkansae* is endemic to the region and it was first described from Arkansas and Missouri populations (Ricker and Ross 1975). Watersheds listed above include the first Oklahoma records. It is most common in the Ouachita and Boston Mountain subregions, and occurs in both permanent and intermittent streams. However, no specimens were collected from habitats that dry up in summer months. Emergence begins in January, somewhat earlier than for other *Strophopteryx* species.

Strophopteryx cucullata Frison

Figs. 20, 160, 169, 173, 174, 182

Strophopteryx cucullata Frison (1934).
Strophopteryx ostra Ricker and Ross (1975), **new synonymy.**

Type locality.— Oklahoma, Latimer County, Boy Scout Camp.

Regional distribution.— Watersheds 1, 2, 5, 7-10, 13, 16, 18, 19, 21, 27, 32-37, 40, 42-46, 52, 54-57, 60, 67, 69-71, 73-75, 77, 78, 80, 82, 90, 104, 116 (Table 1).

The first nymphal description is given here:

NYMPH: (Fig. 182). General color olive-green, brown, or black. Head with narrow pale areas in ocellar triangle and medially; area encircling eyes pigmented. Paired spots on abdominal terga and pleura small, often indistinct. Abdominal banding absent, blotches on thorax absent, small faint rugosities present along anterior edge of wing pads. Femur and tibia with setal fringe along dorsal margin.

Discussion.— The status of this species has been uncertain since Ricker and Ross (1975). Specimens collected by Stark and Stewart (1973b), and identified as *S. cucullata* (including the first described male), were considered as *S. ostra* by Ricker and Ross (1975). Twelve females (nine reared) and eight males (five reared) collected from the Leflore County, Oklahoma locality of Stark and Stewart (1973b) agree with descriptions of *S. cucullata* females (Frison 1934; Ricker and Ross 1975) and Stark and Stewart's (1973b) description of plesiotype *S. cucullata* males. Two females from this series, and females collected from other localities during this study, showed variability in the flap of sternum 9 and sclerotized band of sternum 8 (Figs. 173, 174). Many of these matched *S. ostra* females (Ricker and Ross 1975). Males from regional collections, including this series, fit Ricker and Ross's (1975) description of *S. ostra*. Therefore, we consider *S. ostra* to be a synonym of *S. cucullata*, the latter name having priority.

Males of this species have a sharply pointed spine on the basicercal process (Fig. 160), and female sternum 9 is usually broader than that of *S. arkansae* (Figs. 169, 174). This species was previously reported from northeastern Texas (under *S. ostra*), but Szczytko and Stewart (1977) were unable to locate Texas populations. Based on its apparent requirement for streams with substantial gradients, its presence in Texas is questionable and we consider this species to be endemic to the region. It is common in intermittent streams, and was the only *Strophopteryx* collected from streams that dry up during summer months. This suggests the possibility of a heterodynamic life cycle (Stewart and Stark 1988). It is most common in the Arkansas River Valley, Boston, and Ouachita Mountain subregions, where it emerges from early February to early April.

Strophopteryx fasciata (Burmeister)
Figs. 158, 159, 170, 183

Semblis fasciata Burmeister (1839).
Taeniopteryx (*Strophopteryx*) *fasciata*: Frison (1942).
Brachyptera fasciata: Harden and Mickel (1952).
Strophopteryx fasciata: Illies (1966).

Type locality.— Pennsylvania.

Regional distribution.— Watersheds 1-5, 8, 9, 13, 14, 20, 22, 23, 25-29, 32-34, 36-38, 42-49, 52, 53, 55, 57, 65-68, 71, 72, 74, 76, 77, 80, 81, 83-92, 94-100, 102-104, 106-111, 115-125 (Table 1).

Discussion.— The narrowed tip of male sternum 9 and the trucate, tapered shape of female sternum 9 (Figs. 158, 159, 170) separate this species from other *Strophopteryx*. Nymphs are mottled with blotches on the wingpads, and they have transverse bands on abdominal terga (Fig. 183). It was reported from several regional localities (Frison 1935; Illies 1966; Stark and Stewart 1973a). It is the most widespread species in the genus, and is the only regional *Strophopteryx* common to both north central states, and the Appalachian Mountains. It occupies all subregions except the Gulf Coastal Plain, Mississippi Alluvial Plain, and Crowleys Ridge. Our collections indicate it is probably restricted to permanently flowing streams in mountainous regions. It emerges later than *S. arkansae*, from early February to mid-March.

Taeniopteryx burksi Ricker and Ross
Figs. 18, 19, 34, 150-152, 162, 176, 177

Taeniopteryx burksi Ricker and Ross (1968).

Type locality.— Illinois, Urbana.

Regional distribution.— Watersheds 2-5, 7-9, 13, 14, 17-28, 31-38, 40-45, 47-50, 52-56, 60, 65, 67, 71-74, 76, 77, 79, 80, 82, 83, 85-97, 99-111, 114-126 (Table 1).

Discussion.— Males of this species are distinguished from *T. maura* by the absence of a large spur on the femora, although small knobs and swellings may be present (Fig. 171). It is often confused with *T. nivalis* Fitch (Ricker and Ross 1968), but *T. nivalis* lacks the brown sclerotized band across the male aedeagus (Fig. 150). Nymphs have a mid-dorsal stripe bordered by dark brown or black (Fig. 177). Museum specimens examined from the University of Missouri included collections by Jones et al. (1981), who reported *T. nivalis* from Missouri, but these specimens were *T. burksi*. Stark and Stewart (1973a) and Fullington and Stewart (1980) provided the most recent regional records. This is the most common regional species of *Taeniopteryx*, and was collected in medium to large permanent or intermittent streams in nearly every subregion. Females were observed depositing egg masses on bridges, and flying during warm temperatures. Nymphs inhabit organic debris and leaf packs, and adults emerge from late December to early March.

Taeniopteryx lita Frison
Figs. 155, 167, 181

Taeniopteryx lita Frison (1942).

Type locality.— Illinois, Elizabethtown.

Regional distribution.— AR: Franklin Co., 17-II-62, 1M, L.O. Warren; Polk Co., Mill Cr., 17-II-62, L.O. Warren; Prairie Co., Cache R., Brasfield, 16-IV-39, 1M, H.H. Ross & J.A. Ross; Yell Co: Petit Jean R., Conway Co. line, 9-III-63, 2M, O & M Hite. IL: Hardin Co., Elizabethtown, 7-III-28, 3M, T.H. Frison; Pope Co., Golconda, 17-III-32, 1F, H.H. Ross; Randolph Co., Kaskaskia R., Evansville, 3-II-34, 1M, T.H. Frison & C.J. Mohr. OK: Pushmataha Co., Big Cedar Cr., Hwy 271, 1 km E Finley, 17-II-85, 1F, BCP.

Discussion.— Males of this species can be separated from *T. lonicera* by the short, broad cerci (Fig. 155), and females have a wide, subrectangular sclerotized patch similar to *T. lonicera* (Fig. 167). The nymph has a middorsal stripe that is sometimes discontinuous. It was reported from southern Illinois by Frison (1942), and other localities listed above were provided by Ricker and Ross (1968). Only one female was collected during this study, representing the first Oklahoma record. Regional records probably represent the western edge of its range, but it is not commonly collected. Localities listed above are large, slow moving streams surrounded by bottomland hardwoods (Table 2). Adult collections from mid-February through early April suggest a later emergence than for *T. burksi*.

Taeniopteryx lonicera Ricker and Ross
Figs. 154, 166, 180

Taeniopteryx lonicera Ricker and Ross (1968).

Type locality.— Alabama, Laurel Fork, Blountsville.

Regional distribution.— AR: Clark Co., L' Eau Frais Cr., Hwy 128, 2.2 km S Joan, 5-II-84, reared 3M, 9F, 2n, same data, 15-II-85, 1M, BCP.

Discussion.— This species is similar to *T. lita*, but the male cerci are more elongate and inwardly curved (Fig. 154), and the sclerotization on female sternum 8 is more evenly U-shaped (Fig. 166). Nymphs are not reliably separable from *T. lita*. Stewart et al. (1974) and Stark et al. (1986) reported *T. lonicera* from Louisiana and Texas, respectively. The single regional locality also contained a small, relict population of *Shipsa rotunda*, and is a slow moving, lowland stream with permanent flow. Nymphal collections were made from roots and organic debris, and adults emerged in February.

Taeniopteryx maura (Pictet)

Figs. 153, 163, 175

Nemoura maura Pictet (1841).
Taeniopteryx maura: Frison (1942).

Type locality.— Pennsylvania.

Regional distribution.— Watersheds 11, 12, 15-17, 27, 46,49, 61, 77 (Table 1).

Discussion.— This species resembles *T. burksi*, but males have a pointed femoral spur with a length at least 1/2 the width of the femur (Fig. 172). A rounded knob has been found on some specimens of *T. burksi*, but in general the ranges of these two species overlap very little within the region. Nymphs cannot be separated from *T. burksi* except if mature, when the femoral spur is visible through the cuticle (Fig. 175). Stewart et al. (1988) reported that drumming signals from regional specimens were distinctly different from *T. burksi*. Stark and Stewart (1973a) provided the most recent records from Oklahoma. It is a lowland, Gulf Coastal Plain species, but it was also found in a few large river systems in the southern Ouachita subregion where *T. burksi* is common. It was collected from intermittent streams, but was absent from localities that dry up during the summer months. Emergence occurs from January to mid-March.

Taeniopteryx metequi Ricker and Ross

Figs. 157, 165, 179

Taeniopteryx metequi Ricker and Ross (1968).

Type locality.— Illinois, Hays Creek, Glendale.

Regional distribution.— Watersheds 1, 7, 13, 14, 23, 25, 27, 29, 35-38, 40, 42, 46, 53, 54, 56, 61, 64, 65, 71-73, 77, 80, 86, 89-91, 103, 106, 109, 118, 124 (Table 1).

Discussion.— This species has globular, club-shaped sub-anal lobes in males (Fig. 157, often resembling *T. parvula* when the inner margin of these lobes are dark), and a U- shaped sclerotized band with a wide truncate flap on female sternum 8 (Fig. 165). Males have long legs, and relatively short wings which reach to the tip of the abdomen. Nymphs have a wide, rectangular pale patch on the rear margin of the head (Fig. 180). The most recent records were provided by Ricker and Ross (1968) and Stark and Stewart (1973a), and the region probably represents the southwestern limit of its distribution. It was absent from the Missouri River border and some eastern subregions. This species prefered permanent streams with upland vegetation, and was collected from intermittent streams more frequently than other *Taeniopteryx*. Emergence begins in mid-January and adults were present through mid-March.

Taeniopteryx parvula Banks

Figs. 156, 164, 178

Taeniopteryx parvula Banks (1918).

Type locality.— Virginia, Peach Grove Hill.

Regional distribution.— AR: Montgomery Co: Ouachita River, 2.2 km S Oden, 15-II-85, 1M, BCP; Saline Co., Saline R., Hwy 5, E Owensville, 3-I-85, 2M, 2F, 2 n, BCP; Sevier Co., Cossatot R., 8.8 km W Lockesburg, 6-I-78, 6 n, J. W. McGraw. MO: Miller Co., Maries R., 3 n, location, date, & collector unknown; Madison Co., Castor R., Hwy V, 4.4 km SE Corwall, 6-I-86, 2 n, BCP; Osage Co., Gasconade R., Hwy 89, 6.6 km E Rich Fountain, 26-I-87, R 2M, 3F, 5 n, BCP.

Discussion.— The hook shaped sub-anal lobes of the male (Fig. 156), and the "V" shaped sclerotized notch of the female (Fig. 164), separate this species from *T. metequi*, which it most closely resembles. Most of the nymphs collected from the region did not have a distinct middorsal stripe. Frison (1935, 1942) reported this species from southern Illinois as *T. lita*. Ricker and Ross (1968) reported several Missouri and Arkansas records, and additional localities were added from our collections of 4th order or larger permanently flowing streams (Table 1). The only known large population was in the lower Gasconade River, Missouri, where it was collected in leaf packs and organic debris along the stream margin. Adults were collected in January and Febuary.

Family Nemouridae

Nemourids are small, dark stoneflies that emerge during late winter and spring. Five species occur in the region, and only two were commonly collected. Adults have an extra cross vein in the forewing costal space beyond the cord (Fig. 6). The wings often have blotches or unpigmented "windows" (Baumann 1975). Nymphs have divergent wing pads as in Taeniopterygidae. Adults were commonly collected by sweeping vegetation and searching bridges or streamside debris. Nymphs are abundant in leaf packs and organic debris (Ernst and Stewart 1986), and are considered herbivore- detritivores. Hitchcock (1974) provided the most recent keys to eastern species in this family. *Amphinemura nigritta* is presently considered a complex of several species that are not separated in the key below.

Key to Genera and Species of Nemouridae

Males and Females

1. Remnants of cervical gills present (Fig. 28) .... *Amphinemura* Ris . 2
   Cervical gill remnants absent 3
2. Male sub-anal lobe not recurved at apex with at most, hairs pointing rearward (Fig 144, 145); female subgenital plate with median notch and smaller lateral notches (Fig. 139) .... *A. delosa* (Ricker)
   Male sub-anal lobe recurved at apex forming an elbow-like protrusion pointing rearward (Fig. 146, 147); female subgenital plate with median notch, but lateral indentations appear, at most, as small crevices (Fig. 138) .... *A. nigritta* (Provancher)
3. Male tergum 10 produced into 2 inwardly curved lobes covering cerci (Fig. 143); female subgenital plate rounded, without notch or indentation (Fig. 140) .... *Shipsa rotunda* (Claassen)
   Male tergum 10 without curved lobes; female subgenital plate notched or indented (Figs. 141, 142) .... *Prostoia* Ricker 4
4. Basal process of male epiproct twisted, and nearly 1/2 as long as the epiproct (Fig. 149); female subgenital plate indented, with pointed lateral corners, at most slightly rounded (Fig. 142) .... *P. similis* (Hagen)
   Basal process of male epiproct short, less than 1/5 as long as the epiproct (Fig. 148); female subgenital plate indented, with lateral corners rounded or truncate (Fig. 141) .... *P. completa* (Walker)

Nymphs

1. Highly branched cervical gills present (Fig. 31); prominent fringe of short, stout hairs around pronotum (Fig. 31)... *Amphinemura* Ris
   Gills and prominent pronotal fringe absent (Fig. 29, 30)........ 2
2. Distal end of tibia with a row of stout, short spines (Fig. 32); width of pronotum usually subequal to distance between eyes (Fig. 30) .... *Prostoia* Ricker
   Tibia with, at most, a few small spines at distal end, and appearing banded (Fig. 33); width of pronotum usually less than distance between eyes (Fig. 29)........ *Shipsa rotunda* (Claassen)

Amphinemura delosa (Ricker)

Figs. 28, 31, 139, 144, 145

Nemoura (Amphinemura) delosa Ricker (1952).
Amphinemura delosa: Illies (1966).

Type locality.— Indiana, McCormicks Creek, Spencer.

Regional distribution.— Watersheds 1-5, 7-10, 13, 14, 16-23, 25-28, 31-41, 43-50, 51-58, 60, 61, 65-96, 98, 100-103, 105-111, 114, 116- 126 (Table 1).

Discussion.— This is the most common nemourid from the region. Unlike *A. nigritta*, the male sub-anal lobes are not recurved rearward at the tip, and they have, at most, a few black hairs (Figs. 144, 145). Illies (1966) listed this species in all states encompassing the region, and regional records are probably at the western limit of its range. It is most common in mountainous subregions, including Crowley's Ridge, but is apparently absent from the Mississippi Alluvial Plain. Ernst and Stewart (1986) reported it as a common inhabitant of leaf packs. Emergence occurs in April and May. Based on our collections, some females live up to 6 weeks after emergence and retain their eggs throughout this time.

Amphinemura nigritta (Provancher)

Figs. 138, 146, 147

Nemoura nigritta Provancher (1876).
Nemoura (Amphinemra) nigritta: Ricker (1952).
Amphinemura nigritta: Illies (1966).

Type locality.— Canada, Quebec.

Regional distribution.— AR: Miller Co., May Br., Hwy 160, 2.2 km E Brightstar, 6-IV-84, reared 10 M, 18 F, BCP; Dallas Co., Populi Cr., Hwy 273, 4.4 km SE Forrest Bonner, 17-IV-85, reared 3 M, 1 F, BCP. MO: Callaway Co., Middle R., Hwy H, E of Fulton, 30-IV-72, 1 M, D.A. Boehne.

Discussion.— This species is similar to *A. delosa*, and can be distinguished by the tip of the male sub-anal lobes, which are recurved posteriorly (Figs. 146, 147). Nymphs are not separable from *A. delosa* at this time. Ricker (1952) reported it from Illinois, along with *A. varshava* (Ricker), but these specimens were not available to confirm their presence in southern Illinois. The male sub-anal lobes differed between Gulf Coastal Plain specimens and those from central Missouri, suggesting there may be more than one member of this complex in areas surrounding the region. It was found in small, temporary habitats in the Gulf Coastal Plain, but was not collected in mountainous areas where *A. delosa* was common. Regional collections in April suggest it has an emergence period similar to Texas populations (Szczytko and Stewart 1977).

Prostoia completa (Walker)

Figs. 6, 30, 32, 141, 148

Nemoura completa Walker (1852).
Nemoura (Prostoia) completa: Ricker (1952).
Prostoia completa: Illies (1966).

Type locality.— Canada, Nova Scotia.

Regional distribution.— Watersheds 2-4, 8, 9, 13, 17, 20, 22, 23, 25-28, 32, 35, 36, 38, 41-46, 49, 52, 53, 55-57, 65-68, 71, 72, 81, 83, 85-87, 89, 91-93, 95-100, 102, 104, 107, 109-111, 115-118, 120-125 (Table 1).

Discussion.— This species is distinguished by the widened male epiproct, and the short basal process (Fig. 148). It has been reported from several regional localities (Ricker 1952; Stark and Stewart 1973a; Stark et al. 1986), and its univoltine fast life cycle was recently reported by Ernst & Stewart (1985a) in Oklahoma. It is common in mountainous subregions, in permanently flowing streams (Table 2). The emergence period of February to March is earlier than for *Amphinemura* species.

Prostoia similis (Hagen)

Figs. 142, 149

Taeniopteryx similis Hagen (1861).
Nemoura (Prostoia) similis: Ricker (1952).
Prostoia similis: Illies (1966).

Type locality.— Washington, District of Columbia.

Regional distribution.— MO: Reynolds Co., W. Fk. Black R., Greeley, 23-II-88, reared 1M, 2F, L. Trial; W. Fk. Black R. at jct. mouth of Smalls Cr., 23-II-88, reared 8M, 7F, 5 n, also 2-III-88, reared 1M, 1F, L. Trial.

Discussion.— Males are distinguished from *P. completa* by the long, coiled basal process of the epiproct (Fig. 149). It was recently discovered from the pristine upper Black River system in Missouri. These localities are the first records west of the central Mississippi Valley, and are isolated from other populations in eastern North America. It probably requires permanently flowing streams, and the emergence period is similar to *P. completa*.

Shipsa rotunda (Claassen)

Figs. 29, 33, 140, 143

Nemoura rotunda Claassen (1923).
Nemoura (Shipsa) rotunda: Ricker (1952).
Shipsa rotunda: Illies (1966).

Type locality.— Maine, Waldeboro.

Regional distribution.— AR: Clark Co., L' Eau Frais Cr., Hwy 128, 2.2 km SE Joan, 5-II-84, reared 1M, BCP.

Discussion.— This species is separated from other nemourids by apical abdominal lobes which are curved inward to cover the cerci (Fig. 143). One specimen was collected from a 3rd order stream in the northern edge of the Gulf Coastal Plain, which also contained a relict population of *Taeniopteryx lonicera*. Both *S. rotunda* and *T. lonicera* occupy similar ranges east of the Mississippi River. Emergence of *S. rotunda* is in April and May in more northern latitudes (Ricker 1964).

Family Chloroperlidae

The six regional species of Chloroperlidae emerge in spring and early summer, and have clear, colorless wings. Adults of *Haploperla* are yellow in life, and *Alloperla* are bright green, but both become pale in preservative. The pale nymphs have short cerci, which are equal to 3/4 length of the abdomen. The adults can be collected by sweeping riparian vegetation, and with blacklights. Nymphs were often collected from finer gravel in the slower portions of riffle areas. Ernst and Stewart (1986) found *H. brevis* was a generalist in an Oklahoma stream, but Stewart and Stark (1988) reported most chloroperlid nymphs as predacious engulfers. Records and descriptions of new spepcies have recently become available (Stark et al. 1983; Poulton and Stewart 1987). The key below is the first to include both males, females, and nymphs of regional *Alloperla*. The nymph of *Alloperla leonarda* remains unknown.

Key to Genera and Species of Chloroperlidae

Males and Females

1. Hind wing without anal lobe (Fig. 7); body yellow in life; female subgenital plate rounded (Fig. 201); male epiproct triangular (Fig. 196) .... ***Haploperla brevis*** (Banks)
   Hind wing with anal lobe; body green in life; female subgenital plate variable, male epiproct slender, not triangular (Figs. 185-194) .... ***Alloperla*** Banks 2
2. Male epiproct with lateral spines and/or serrations (Figs. 186, 188, 194); female subgenital plate pointed (*A. caudata*, Fig. 197, often slightly pointed) (Figs. 199, 200, 202) 3
   Male epiproct smooth or bearing fine silky hairs (Figs. 189-192); female subgenital plate rounded or with slight knob (Figs. 197, 198) 5
3. Male epiproct tip truncate, with lateral serrations and small spines (Fig. 186), and flat in lateral aspect (Fig. 185); female subgenital plate with broad point extending from widened ridge (Fig. 199) .... ***A. hamata*** Surdick
   Male epiproct tip with lateral spines, but serrations absent (Figs. 188, 194), wide in lateral aspect (Figs. 187, 193); female subgenital plate without widened ridge, but may have broad point (Figs. 200, 202) 4

4. Male epiproct oval in dorsal aspect, with lateral spines apically (Fig. 188); female subgenital plate with broad point (Fig. 202) .... *A. ouachita* Stark and Stewart
Male epiproct narrower in dorsal aspect, apex "T"-shaped (Fig. 194); female subgenital plate narrowly pointed (Fig. 200)........... .... *A. leonarda* Ricker
5. Male epiproct elevated at apex, appearing boot-shaped (Fig. 189); female subgenital plate rounded (Fig. 198) .... *A. caddo* Poulton and Stewart
Male epiproct oval, covered with fine silky hairs (Figs. 191, 192); female subgenital plate blunt, gradually pointed (Fig. 197)....... .... *A. caudata* Frison

Nymphs

1. Inside margin of mature wing pads nearly parallel (Fig. 205); setae around entire margin of pronotum (Fig. 205)................. .... ***Haploperla brevis*** (Banks)
Inside margin of mature wing pads divergent (Fig. 208); setae mostly restricted to corners of pronotum (Fig. 208) . . ***Alloperla*** Banks **2**
2. Rear corners of head slightly angulate (Fig. 208) .... *A. hamata* Surdick
Rear corners of head evenly rounded (Figs. 206, 207) **3**
3. Setal fringe on femora and tibia short, sparse (Fig 204) .... *A. caddo* Poulton and Stewart
Setal fringe on femora and tibia dense, equal to femur width (Fig. 203) **4**
4. Labrum paler than posterior margin of head (Fig. 206) .... *A. caudata* Frison
Pigmentation of labrum about same as posterior margin of head (Fig. 207) .... *A. ouachita* Stark and Stewart

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Alloperla caddo Poulton and Stewart
Figs. 189, 190, 198, 204

Alloperla caddo Poulton and Stewart (1987).

Type locality.— Arkansas, Garland County, Middle Fork SalineRiver, Iron Springs Recreation Area.

Regional distribution.— AR: Garland Co., M. Fk. Saline R., Hwy 7, Iron Spgs. Rec. Area, 6-VI-84, 8 M, 5 F, BCP; Perry Co., Dry Fk. Cr., Hwy 7, 14.3 km S Hollis, 6-VI-84, 4 M, 1 F, BCP; Bear Cr., Hwy 7, 4.4 km SE Hollis, 12-V-85, 4 M, 1 n, 1 ex, BCP; Scott Co., Big Cedar Cr., Hwy 28, 6.6 km E Cedar Creek, 14-V-85, 1 F, BCP.

Discussion.— This species is distinguished from other regional *Alloperla* by the saddle-shaped epiproct in males (Figs. 189, 190), and the rounded female subgenital plate (Fig. 198). Nymphs have a sparse setal fringe on the outer edge of the femur (Fig. 204). It is endemic to the Ouachita subregion and considered rare (Poulton and Stewart 1987). Adults were collected from small, intermittent streams in May and June.

Alloperla caudata Frison
Figs. 10, 191, 192, 197, 203, 206

Alloperla caudata Frison (1934).

Type locality.— Oklahoma, Adair County.

Regional distribution.— Watersheds 3, 4, 8, 22, 23, 28, 32, 35, 45, 46, 49, 53, 57, 65, 66, 71, 81, 83, 86, 91, 95, 96, 102, 107, 116-118, 121-123, 125 (Table 1).

Discussion.— This species was the only common *Alloperla* collected from the region. The male epiproct is oval and smooth, and lacks lateral spines or serrations (Fig. 192). It has been reported from several regional localities (Frison 1934; Illies 1966; Stark et al. 1983; Ernst and Stewart 1985b). The region probably represents the southwestern limit of its range. It was absent from streams that dry up during late summer (Table 2), and preferred mountanous subregions. No records are know from the Mississippi Alluvial and Gulf Coastal Plains, or Crowley's Ridge. Emergence begins in late April and continues through mid June.

Alloperla hamata Surdick
Figs. 185, 186, 199, 208

Alloperla hamata Surdick (1981).

Type locality.— Alabama.

Regional distribution.— AR: Johnson Co., Washita Cr., Hwy 103 S. Oark, 19-IV-85, reared 1M, 1F, field 17M, 1F, 4 n, 4 ex, BCP; Montgomery Co., L. Missouri R., 20-IV-80, 1M, E.J Bacon, J.W. Feminella. MO: Christian Co., Bull Cr., 10-V-72, 29M, B.K. Newman.

The first nymphal description is provided here:

NYMPH: (Fig. 208). General color pale yellow to light brown. Contrasting colors generally lacking, except on head. Labrum, posterior margin of head, and area encircling eyes darker than ocellar triangle. Posterior corners of head slightly angulate, eyes set slightly anteriorly (Fig. 208). Pronotum oval, slightly wider than long. Pronotal setae longest at corners. Femora and tibia with numerous long setae subequal to femur width along outer edge.

Disussion.— Males of this species have a wide, flattened epiproct with lateral serrations (Fig. 186). Nymphs are distinguished from other regional *Alloperla* by the slightly angulate posterior corners of the head (Fig. 208). Regional populations are isolated from those in Alabama, and the epiproct exhibits geographical variation (Stark et al. 1983). The cool, rock-rubble streams it inhabits may represent glacial relict habitats. Nymphs collected from Washita Creek were found in patches of fine gravel in slower currents behind large boulders. Emergence occurs in April and May.

Alloperla leonarda Ricker
Figs. 193, 194, 200

Alloperla leonarda Ricker (1952).

Type locality.— Minnesota, Pine County, Big Sand Creek.

Regional distribution.— MO: Christian Co., Bull Cr., Hwy W, S of Ozark, 10-V-72, 13M, B.K. Newman.

Discussion.— This species has lateral spines on the male epiproct (Fig. 194), and a narrow, pointed female subgenital plate (Fig. 200). It was only collected at one regional locality (Stark et al. 1983), a permanently flowing, spring-fed stream similar to those of more northern latutudes where it is more common. Our collections from this locality have not provided additional specimens, but many *A. caudata* were collected. The nymph of this species is unknown, and adults emerge in May and early June.

Alloperla ouachita Stark and Stewart
Figs. 187, 188, 202, 207

Alloperla ouachita Stark et al. (1983).

Type locality.— Arkansas, Montgomery County, LittleMissouri River.

Types.— Allotype F, AR: Hot Spring Co., Big Hill Cr., Hwy 7, 18-IV-85, BCP. Allotype in USNM.

Regional distribution.— AR: Hot springs Co., Big Hill Cr., Hwy 7, 18-IV-85, 5M, 14F, 2n, BCP; Montgomery Co., L. Missouri R., Albert Pike Campground, 20-VI-80, 17M, E.J. Bacon and J.W. Feminella.

The first female and nymph descriptions are given below:

FEMALE: (Fig. 202). Forewing length 8 mm, body length 7 mm. General color white in alcohol, abdominal stripes absent. Subgenital plate with broad point, covering 1/2 of sternum 9.

NYMPH: (Fig. 207). General color pale yellow to light brown. Contrasting coloration generally lacking, except on head. Head slightly elongate; labrum, posterior margin of head, and ocellar triangle darker than ecdysial suture and area encircling eyes (Fig. 207). Posterior corners of head evenly rounded. Pronotum oval, slightly wider than long. Pronotal setae longest at corners, femora and tibiae with setal fringe along outer edge; setal length subequal to femur width.

Discussion.— One additional locality (Hot Spring Co. given above) was discovered for this rare species, which is endemic to the Ouachita Mountain subregion. Males have an oval, bulbous epiproct with a pair of lateroapical spines (Fig. 188). Nymphs were found in leaf packs and patches of fine gravel, in small, clear, rapid, rocky streams. Adults emerge from mid-April to early June.

Haploperla brevis (Banks)
Figs. 195, 196, 201, 205

Chloroperla brevis Banks (1895).
Hastaperla brevis: Frison (1942).
Haploperla brevis: Zwick (1977).

Type locality.— Canada, Sherbrook.

Regional distribution.— Watersheds 1-5, 7-10, 13, 14, 16-23, 25-28, 31, 33-49, 52-58, 60, 61, 64-74, 76-87, 89-105, 107-111, 114-125 (Table 1).

Discussion.— This was the most commonly collected chloroperlid, and can be distinguished by its bright yellow color and no fold in the hind wing (Fig. 7). Wing pads of mature nymphs have nearly parallel inner margins (Fig. 205). Illies (1966) noted the presence of this species in all states encompassing the region. Ernst and Stewart (1986) reported nymphs to be generalists in an Oklahoma stream, occupying fine gravel with high FPOM. Although most common in mountainous areas, it was collected from every subregion, and is the only chloroperlid known from Crowley's Ridge. Adults are present from mid-April through early June.

Family Perlidae

There are 28 perlid species in the region, and most emerge in late spring and summer. The adults have remnants of gills on the thorax, and the cubito-anal crossvien of the forewing is set at the anal cell, or removed from it by a distance less than its length (Figs. 12, 14). Nymphs have thoracic gills, contrasting pigmentation, and are carnivorous engulfers (Stewart and Stark 1988). Ernst and Stewart (1986) found *Agnetina* and *Acroneuria* to be associated with CPOM (leaf packs), due to the presence of their food source, but substrates containing interstitial organic matter are also good nymphal habitats, especially in larger streams. Adults were collected shortly after emergence in water willow and other streamside vegetation, but because they emerge during warmer seasons when insects are more active, they quickly flew into the riparian canopy, and therefore adult collections of perlids were often limited to those taken from blacklights.

Several observations of adult behavior are noteworthy. Ernst and Stewart (1985b) found many perlids exhibited synchronous emergence in the region, and lived longer as adults than species of other families. Many species were collected as long as 6-8 weeks after disappearance of nymphs from stream collections. Blacklight trapping was selective for females, with about a 20:1 ratio (females to males) observed. Blacklight collections have revealed that larger numbers of adults can be collected when open areas were chosen for placement of the light. This allowed a larger unobstructed field from which adults could be attracted. Collections at the same stream on successive nights with similar weather conditions confirmed this, and placement of a blacklight at some localities yielded a 25 liter bucket of adult perlids in less than 15 minutes.

Adults were collected in numbers from locations several miles from the nearest stream on windy evenings. This suggests that dispersal flights, possibly aided by wind, are common in *Acroneuria* and *Neoperla*. Species from these genera were collected with a blacklight set up at very small streams that had dried up previously, and were 11-22 km from the larger streams of their presumed origin. Such collections included females with extruded egg masses on their abdomens. *Acroneuria evoluta* nymphs were collected from small, first order streams that dried up by early June, and no additional specimens were present in following years. These observations may suggest reasons why some perlid species are not found in given streams during successive years: 1) adults may spend daylight hours in the vegetation canopy a considerable distance from the stream, 2) they may undergo dispersal flights, often miles from the stream from which they emerged, 3) they may lay eggs that undergo diapause, or 4) chance dispersal to unsuitable streams results in nymphal development only during wet years, causing these streams to be inconsistent in nymphal production.

The emergence of members of this family during the warmest months of the year caused special problems in field transport and rearing of nymphs. Most species were collected as pre-emergent nymphs, and successful rearing required frequent changing of water in the styrofoam chambers. *Acroneuria* nymphs were often absent during the two months prior to emergence in many streams, and most species were collected in January and February and transported to the laboratory where they could be individually fed and reared in an artificial stream for 4-8 weeks. These rearing difficulties and the numerous congeners in *Acroneuria*, *Neoperla*, and *Perlesta* have hampered the species delineation of nymphs of regional fauna, and in the Perlidae in general. The regional aspect and lack of descriptive detail have made other keys to northeastern *Acroneuria* nymphs (Hitchcock 1974; Unzicker and McCaskill 1982) of limited use for Ozark-Ouachita nymphs.

The key below represents the first attempt to separate nymphs of any regional *Neoperla* and *Perlesta* fauna to the species level, and incorporates the latest systematic changes in these groups (Ernst et al. 1986; Stark and Lentz 1988; Stark 1990a, 1990b). Stewart and Stark (1988) pointed out that the assumed variability of color patterns in stonefly nymphs is often due to inadequate comparisons of reared series of regional congeners. We generally found distinct patterns among perlid congeners of the Ozark- Ouachita fauna, but differences were often subtle. Comparisons of Ozark and Wisconsin populations of *Agnetina capitata*, *Agnetina flavescens*, and *Paragnetina media* showed that genitalia matched well, but Wisconsin specimens were typically darker in their color patterns. Key illustrations depict only characters of Ozark-Ouachita populations. Pre-emergent nymphs or adults of *Neoperla* can be dissected to reveal the aedeagal tube or spermatheca aiding in their identification. However, the aedeagus of adult *Perlesta* and *Acroneuria* males should be extruded in the field. The nymphs of *Acroneuria ozarkensis* and *Neoperla carlsoni* are unknown.

Key to Genera and Species of Perlidae

Males and Females

1. Two ocelli .... *Neoperla* Needham **13**
   Three ocelli (some *Perlinella* have median ocellus reduced, Figs. 359, 360) **2**
2. Males **3**
   Females **8**
3. Genital hooks arising from tergum 10 (Figs. 285-290) **4**
   Genital hooks arising from paraprocts (Figs. 245-251, 312-315, 365-366) **5**
4. Genital hooks long, extending forward to tergum 8 (Figs. 289, 290) .... ***Agnetina*** Klapalek **19**
   Genital hooks short, extending to tergum 9 (Figs. 287, 288) .... ***Paragnetina*** Klapalek **20**
5. Hammer absent from sternum 9 (Fig. 45) .... ***Perlesta*** Banks **21**
   Hammer present on sternum 9 (Fig. 44) **6**

6. Hind corners of head angulate, eyes set far forward (Figs. 359, 360); small species, forewing shorter than 15mm *Perlinella* Banks **26**
Hind corners of head not angulate (Fig. 281); large species, forewing longer than 15mm **7**
7. Spinule patches present on tergum 9 and 10 (Figs. 246-251) .... *Acroneuria* Pictet **27**
Spinule patches absent from tergum 9 and 10, a few spinules present on tergum 10 (Fig. 245)............ *Attaneuria ruralis* (Hagen)
8. Hind corners of head angulate, eyes set far forward (Figs. 359, 360); sternum 8 with V-shaped sclerotization and rectangular notch (Figs. 361, 362) .... *Perlinella* Banks **26**
Hind corners of head evenly rounded, eyes set normally (Fig. 281); sternum 8 without V-shaped sclerotization **9**
9. Small species, forewing less than 13 mm; subgenital plate notched, overlapping 1/3 of sternum 9 (Figs. 334-336, 338, 339), or margin sinuate (Fig. 337) .... *Perlesta* Banks **21**
Larger species, forewing more than 13 mm; subgenital plate variable (Figs. 264-275, 291-294) **10**
10. Subgenital plate with submarginal tubercle (Fig. 275) .... *Attaneuria ruralis* (Hagen)
Subgenital plate without a submarginal tubercle (Figs. 264-274, 291-294) **11**
11. Anterior portion of head almost uniformly brown, lacking pigment contrast (some species have darker, sinuate"W" pattern or light posterior margin, Fig. 281); subgenital plate variable (Figs. 264-274) .... *Acroneuria* Pictet **27**
Anterior portion of head with contrasting pigment (Figs. 303, 304, 310, 311); if head mostly dark, subgenital plate is a small, U-shaped projection (Figs. 291, 292)... **12**
12. Subgenital plate broadly rounded, covering 1/2 of sternum 9, rarely with a slight notch (Figs. 293, 294) ...... *Agnetina* Klapalek **19**
Subgenital plate with a U-shaped notch, usually covering 1/2 or less of segment 9 (Figs. 291, 292) .... *Paragnetina* Klapalek **20**
13. Male aedeagal tube with external spines (Figs. 217, 218, 220); female spermatheca short (Fig. 233- 235); anterior margin of female sternum 8 entire (Figs. 225, 228, 229) **14**
Male aedeagal tube without external spines (Figs. 216, 219, 221); female spermatheca long, partially coiled (Figs. 230-232, 236); female sternum 8 with rectangular, triangular, or sub-circular indentation along anterior margin (Figs. 223, 224, 226, 227).......... **16**
14. Male genital hooks straight (Fig. 214); female spermatheca curved, narrowing toward tip (Fig. 235); egg smooth................. .... *N. catharae* Stark and Baumann
Male genital hooks slightly recurved (Figs. 213, 215); female spermatheca triangular (Fig. 233), or not narrowed at tip (Fig. 234); egg covered with punctations.. **15**
15. Male femora banded distally near articulation (Fig. 238); female spermatheca curved, and striate (Fig. 234); egg collar absent .... *N. choctaw* Stark and Baumann
Male femora broadly banded, pigmentation covers entire dorsal surface (Fig. 237); female spermatheca triangular, striations indistinct or absent (Fig. 233); egg collar present .... *N. carlsoni* Stark and Baumann
16. Male genital hooks short and straight (Fig. 209); male aedeagal tube short, with ventral bulb subequal to 2 1/2 X total tube length (Fig. 219); female spermatheca coiled one revolution or less in-situ and tip of spermatheca not narrowed or tapered (Fig. 231)........ .... *N. osage* Stark and Lentz
Male genital hooks longer and at least slightly recurved (Figs. 210-212); total length of aedeagal tube greater than 3X width of ventral bulb (Figs. 216, 221, 222); female spermatheca either narrowed at tip (Fig. 236), or coiled more than one revolution in-situ (Fig. 232) **17**
17. Tip of male aedeagus (visible through tube wall) with rows of dense, small spines (Fig. 222); female spermatheca coiled more than one revolution in-situ, its tip not narrowed (Fig. 232).. *N. falayah* Stark and Lentz
Tip of male aedeagus with medium to large sized spines, not in dense rows (Figs. 216, 221); female spermatheca coiled one revolution or less in-situ, tapered and slightly recurved at tip (Figs. 230, 236).. **18**
18. Male genital hooks only slightly recurved (Fig. 210); male aedeagal tube ca. 4-5x length of ventral bulb (Fig. 221); dense brown setae on female spermatheca with serrations along edge (Fig. 230); anterior indentation of female sternum 8 subcircular (Fig. 224); egg without striations.. *N. harpi* Ernst and Stewart
Male genital hooks strongly recurved (Fig. 212); aedeagal tube long, ca. 6-7X ventral bulb (Fig. 216); dense brown setae of female spermatheca without serrations along outer edge (Fig. 236); anterior indentation of female sternum 8 a triangular notch (Fig. 226); egg with striations.. *N. robisoni* Poulton and Stewart
19. Tip of male genital hooks long, appearing oval in lateral aspect (Fig. 290); ocellar triangle dark, pigmented lobes extending from anterior corners (Fig. 304); female sternum 9 with poorly defined lateral rectangular patches (Fig. 294) .... *A. capitata* (Pictet)
Tip of male genital hooks short, appearing triangular or bluntly pointed in lateral aspect (Fig. 289); head with ocellar triangle dark, pigment at anterior corners extends laterally toward eyes (Fig. 303); rectangular patches of female sternum 9 with contrasting dark pigment posteriorly (Fig. 293).. *A. flavescens* (Walsh)
20. Male genital hooks rounded and globular in dorsal aspect (Fig. 287); posterior margin of tergum 5 overlapping part of tergum 6 (Fig. 287); female subgenital plate a small U-shaped notch not overlapping more than 1/4 of tergum 9 (Fig. 291); ocellar triangle and adjacent areas of head dark (Fig. 310).. *P. media* (Walker)
Male genital hooks pointed in dorsal aspect (Fig. 288); posterior margin of tergum 5 similar to other terga (Fig. 288); female subgenital plate with small notch overlapping at least 1/2 of tergum 9 (Fig. 292); ocellar triangle pigmented with inverted "V", rest of head pale (Fig. 311).. *P. kansensis* (Banks)
21. Male paraprocts nearly as broad as wide basally, and curved outward (Fig. 318); costal margin of wings entirely black (Fig. 320); head nearly completely dark, (Fig. 352); female subgenital plate sinuate (Fig. 337) .... *P. baumanni* Stark
Male paraprocts not as above (Figs. 312-317); costal margin of wings amber, at least posteriorly (Fig. 319); head with pale areas near eyes or elsewhere (Figs. 346-351) and/or female subgenital plate with distinct notch (Figs. 334-336, 338, 339)............. **22**
22. Tip of male paraprocts narrowly pointed (Figs. 314, 317); spur located far from pointed apex, appearing saggitate (Figs. 329, 332); pigmentation present along posterior margin of head, contrasting pale areas adjacent to eyes (Figs. 347, 351)................. **23**
Male paraprocts broad (Figs. 312, 315, 316), spur located close to rounded apex (Figs. 328, 330, 331); pigmentation along posterior margin of head indistinct or absent (Figs. 348-350), or if present, area between lateral ocelli and eyes also dark (Fig. 346).... **24**

23. Male paraprocts spine-like, appearing stalked, never curved outward (Fig. 317); dark pigment on femora extends to tibial articulation (Fig. 344); pronotal stripe absent or weak (Fig. 351). . . . . **P. browni** Stark
Male paraprocts long, evenly curved outward (Fig. 314); dark pigment on femora separated by pale areas at tibial articulation (Fig. 342); pronotal stripe usually present (Fig. 347). . . . . **P. cinctipes** (Banks)
24. Male paraprocts nearly as broad as long basally, appearing triangular (Fig. 315); forewing black, posterior portion of costal margin yellow (Fig. 321); head nearly completely pigmented (Fig. 346); dark pigment on femora present only on dorsal margin (Fig. 341); dark pigment present on some abdominal sterna (Fig. 324). . . . . **P. fusca** Poulton and Stewart
Male paraprocts narrow, and may be curved outward (Figs. 312, 313, 316); wings amber, costal margin pale or nearly so (Fig. 319); head pigmentation limited to ocellar quadrangle (sometimes anterior margin, Figs. 348-350); dark pigment absent from sterna, but may be present on terga and pleura (Figs. 322, 325). **25**
25. Male paraprocts with wide band of dark pigment along outer margin (Figs. 312, 313); male aedeagus with raised shelf-like swelling (Fig. 322); female subgenital plate notch deep (Fig. 336); pronotal stripe absent (Figs. 348, 349). . . . . **P. decipiens** (Walsh)
Male paraprocts with, at most, a narrow band of dark pimentation along outer margin, or none (Fig. 316); male aedeagus without a raised swelling (Fig. 325); teneral adult head with inverted "V" connecting ocelli; pronotal stripe present (Fig. 350); female subgenital plate notch shallow (Fig. 335) . . . . **P. shubuta** Stark
26. Pronotum with 2 completely separated pale stripes (Fig. 360); male paraprocts wide (Fig. 366) . . . . **P. drymo** (Newman)
Pronotum with pale stripes connected to other pale areas (Fig. 359); male paraprocts narrower (Fig. 365). . . . . . **P. ephyre** (Newman)
27. Male aedeagus with 1 or 2 apical spinule patches separated from other spinule patches by membranous areas (Figs. 252-259); male genital hooks curved inward along their entire length (Figs. 247, 249-251); abdomen light brown to yellow, lacking contrasting pigment (Figs. 264-271) **28**
Male aedeagus without apical spinule patches (Figs. 262, 263), or if present, are connected to other spinule patches (Figs. 260, 261); male genital hooks straight, or at most, hooked at tip (Fig. 248), or if curved as above, abdomen dark brown with contrasting pale areas on sterna (Fig. 274) **31**
28. Dorsal aspect of male aedeagus with 1 rectangular apical spinule patch (Fig. 258); female subgenital plate usually evenly rounded, covering 1/3 or less of sternum 9 (Figs. 264, 265). . . . . **A. perplexa** Frison (in part)
Dorsal aspect of male aedeagus with 2 oval apical spinule patches (Fig. 256), or a single "V" - shaped patch (Figs. 252, 254); female subgenital plate covers more than 1/3 of sternum 9 (Figs. 266, 271). **29**
29. Male genital hooks blunt, not sharply pointed, but may be hooked at tip (Fig. 247); basal spinule patch of male aedeagus without elongate longitudinal band ventrally (Fig. 255); subgenital plate as wide at base as apex, and usually rounded (Figs. 270, 271). . . . . **A. evoluta** Klapalek (in part)
Male genital hooks sharply pointed (Fig. 250, 251); basal spinule patch of male aedeagus with longitudinal band ventrally (Figs. 253, 257); female subgenital plate wider at base than at apex (Figs. 266-269). **30**
30. Male genital hooks thick, stout (Fig. 250); dorsal aspect of male aedeagus with 2 oval apical spinule patches (Fig. 256); base of female subgenital plate narrow, 1/3 total width of sternum 8 (Figs. 268-269). . . . . **A. mela** Frison
Male genital hooks thin, narrow (Fig. 251); dorsal aspect of male aedeagus with 1 lobed apical spinule patch (Fig. 252); base of female subgenital plate wide, 1/2 total width of sternum 8 (Figs. 266, 267). . . . . **A. filicis** Frison
31. Apical spinule patches on male aedeagus absent (Figs. 262, 263); male genital hooks straight, at most slightly hooked at tip (Fig. 248); female subgenital plate bearing 2 flap-like lobes (Figs. 272, 273). . . . . **A. internata** (Walker)
Apical spinule patches present, either separated by membranous areas (Figs. 254, 258), or continuous with basal spinule patch (Figs. 260, 261); male genital hooks straight or curved; female subgenital plate without 2 flap-like lobes. **32**
32. Male genital hooks curved (Fig. 246); apical spinule patch encircles entire male aedeagus (Figs. 260, 261); subgenital plate evenly rounded (Fig. 274); head brown, with yellow contrast along posterior margin (Fig. 281). . . . . **A. ozarkensis** Poulton and Stewart
Male genital hooks straight, at most slightly hooked at tip (Fig. 249); apical spinule patches not encircling entire aedeagus, but separated by membranous areas (Figs. 254, 258); female subgenital plate variable (Fig. 265,271); head more or less uniformly brown . . **33**
33. Ventral aspect of male aedeagus lacking longitudinal spinule patch (Fig. 255); apical spinule patch not rectangular (Fig. 254); female subgenital plate covering at least 1/2 of sternum 9 (Figs. 270, 271). . . . . **A. evoluta** Klapalek (in part)
Ventral aspect of male aedeagus with longitudinal spinule patch present, widened apically (Fig. 259); apical spinule patch rectangular (Fig. 258); female subgenital plate covering less than 1/2 of segment 9 (Figs. 264, 265) . . . . **A. perplexa** Frison (in part)

Nymphs

1. Two ocelli (some *Perlinella* have median ocellus greatly reduced) (Figs. 239-244) . . . . ***Neoperla*** Needham 7
Three ocelli. **2**
2. Occiput with closely set, regularly spaced row of spinules extending from postocular fringe, more or less completely across head (Fig. 22) **3**
Spinule row either surrounding eyes (Fig. 24), or sinuate and irregularily spaced (Fig. 23), or absent. **4**
3. Posterior spinule fringe of sternum 7 complete (Fig. 41); basal cercal segments without fringe of long setae along inner margin . . . . ***Agnetina*** Klapalek **12**
Posterior spinule fringe of sternum 7 incomplete (Fig.40); basal cercal segments with long setae along inner margin . . . . ***Paragnetina*** Klapalek **13**
4. Spinule row on occiput of head sinuate, irregularly spaced; pronotum with fringe of numerous long bristles (Figs. 23, 280) . . . . ***Attaneuria ruralis*** (Hagen)
Occiput with, at most, a few spinules with large spaces between them, not arranged in a row (Fig. 24); pronotum with short bristles or pegs, or at most, a few long bristles (Fig. 24). **5**

5. Eyes set far forward (Figs. 363, 364); postocular fringe of spinules around eyes lacking or absent (Figs. 363, 364)................ .... ***Perlinella*** Banks **15**
Eyes set further rearward (Figs. 353-358, 276-283); postocular fringe of spinules present (Figs. 276-283)...................... **6**
6. Abdominal terga banded (sometimes unicolorous in *A. mela* and *A. abnormis* (Figs. 295-298), dark intercalary setae lacking .... ***Acroneuria*** Pictet **16**
Abdominal terga not banded, with dark intercalary setae usually numerous (Fig. 47) .... ***Perlesta*** Banks **23**
7. Head with brown band extending from ocelli to anterior margin of eyes, leaving a closed pale window (Fig. 241) .... ***N. harpi*** Ernst and Stewart
Head without brown band between ocelli and eyes (Fig. 240), or if present, not reaching eye margins (Figs. 239, 242-244)........ **8**
8. Brown pigment of pronotum extends posteriorly along pronotal suture, often meeting posterior margin of pronotal ring (Fig. 244) .... ***N. robisoni*** Poulton and Stewart
Brown pigment encircles pronotum more or less evenly (Figs. 239-240, 242-243).. **9**
9. Brown pigment band across head wide, extending posteriorly to eyes (Fig. 242)........................ ***N. osage*** Stark and Lentz
Brown pigment band across head narrower, about 1/3 width of its anterior margin, or less (Fig. 239), but somtimes extending posteriorly to eyes (Figs. 240, 243).. **10**
10. Brown pigment band across head narrow, posterior margin sinuate; anterolateral margin of head lacking dark pigment (Fig. 239) .... ***N. falayah*** Stark and Lentz
Brown pigment band across head wider, posterior margin, at most, slightly sinuate; anterolateral margin of head with some dark pigment (Figs. 240, 243).. **11**
11. Margin of anterolateral corners of head dark (Fig. 240); mature nymphs found in late June and July ***N. choctaw*** Stark and Baumann
Margin of anterolateral corners of head unpigmented (Fig. 243); mature nymphs found in late July and August.................. .... ***N. catharae*** Stark and Baumann
12. Yellow mask anterior to median ocellus sinuate, nearly closed (Fig. 305); dark bands on abdominal terga at or nearest the anterior margin (Fig. 300).. ***A. flavescens*** (Walsh)
Yellow head mask anterior to median ocellus open, not sinuate (Fig. 306); dark bands on abdominal terga at or nearest the posterior margin (Fig. 299).. ***A. capitata*** (Pictet)
13. Diagonal pale bands absent from head, at most small pale spots posterior to occipital ridge (Fig. 308) .... ***P. media*** (Walker), dark phase
Pale diagonal bands present (may not be continuous), converging from eyes to posterior margin of head (Figs. 307, 309)........ **14**
14. Pale bands extending diagonally from eyes, often broken along occipital ridge (Fig. 309); pale area adjacent to lateral ocelli small, broken into 2 patches near each ocelli (Fig. 309); dark pigment touches eyes laterally, and sometimes posteriorly ... ***P. kansensis*** (Banks)
Pale bands extending diagonally from eyes broken by dark pigment, both at occipital ridge and posterior margin of head (Fig. 307); pale area adjacent to lateral ocelli large, not divided into 2 separate patches (Fig. 307); dark pigment does not touch lateral or posterior margin of eye.. ***P. media*** (Walker), light phase
15. Contrasting pigmentation present, head with "W" anterior to median ocellus (Fig. 363).................... ***P. drymo*** (Newman)
Entire nymph pale, lacking contrasting pigmentation (Fig. 364) .... ***P. ephyre*** (Newman)
16. Pale window anterior to median ocellus open, continuous, sometimes forming a "W" (Fig. 276-279)........................ **17**
Pale window anterior to median ocellus closed, forming 3 separated patches (Fig. 282-283)............................ **21**
17. Pale window anterior to median ocellus wide, not forming a "W" (Figs. 276, 277)................ ***A. evoluta*** Klapalek, light phase
Pale window anterior to median ocellus forming a "W" (Figs. 278, 279) **18**
18. Some abdominal terga completely dark, with pale areas small or absent........................ ***A. abnormis*** (Newman) (in part)
Abdominal terga banded (Figs. 295, 297, 298), sometimes with dark pigment reaching posterior margin (Fig. 296).............. **19**
19. Banding on abdominal terga includes dark blotches reaching posterior margin, leaving 3 separate pale areas (Fig. 296)........... .... ***A. filicis*** Frison
Banding on anterior margin of abdominal segments only (Figs. 297, 298).. **20**
20. Pale area adjacent to lateral ocelli usually larger than ocelli, and closed or nearly so (Fig. 279); banding on abdominal segments widest dorsally (Fig. 297) .... ***A. perplexa*** Frison
Pale area adjacent to lateral ocelli usually smaller than ocelli, and connected to other pale areas (Fig. 278); banding on abdominal segments widest laterally (Fig. 298).. ***A. evoluta*** Klapalek, dark phase
21. Abdominal terga with dark band along anterior margin (Figs. 297, 298); dark posterior margin of head diffuse, not reaching laterally to eyes (Fig. 282) .... ***A. internata*** (Walker)
Banding on abdomonal terga broken, not touching anterior margin, or absent (Fig. 295); posterior margin of head with dark band reaching laterally to eyes (Fig. 283), or absent.. **22**
22. Abdominal terga light brown, with dark brown band widened laterally (Fig. 295) .... ***A. mela*** Frison
Abdominal terga lacking pigment contrast, sometimes with a few small pale patches.............. ***A. abnormis*** (Newman) (in part)
23. Head mask consisting of brown freckles (Fig. 355).. ***P. shubuta*** Stark
Head mask consisting of dark pigmentation, freckles not contributing to dark appearance of mask (Figs. 353, 354, 356-358)..... **24**
24. Head mask darker than rest of brown areas on head (Figs. 356-358).. **25**
Head mask not darker than rest of brown areas on head, brown pigmentation more or less uniform (Figs. 353, 354)............. **28**
25. Pale "W" anterior to head mask present, usually complete (Fig. 356) **26**
Pale "W" anterior to head mask broken into separate pale areas (Fig. 358), or area anterior to mask entirely pale, or nearly so (Fig. 357) **27**
26. Pronotal ring as dark as head mask (Fig. 356); pale "W" anterior to mask continuous........................ ***P. cinctipes*** (Banks)
Pronotal ring paler than head mask, often reticulate (Fig. 358); brown band anterior to mask weak, pale "W" between them barely visible .... ***P. decipiens*** (Walsh) (in part)

27. Brown band anterior to head mask with irregular posterior margin (Fig. 357), or this band absent; brown patches between lateral ocelli and eyes absent (Fig. 357).. *P. browni* Stark
Brown band anterior to head mask fused to mask, leaving 3 pale areas (Fig. 358); brown patches between lateral ocelli and eyes weak .... *P. decipiens* (Walsh) (in part)
28. Pale "W" anterior to head mask complete (Fig. 353); posterior margin of head with irregular dark blotches.. *P. fusca* Poulton and Stewart
Pale "W" anterior to head mask incomplete, leaving separate pale areas (Fig. 354); posterior margin of head may be dark, but without irregular blotches.. *P. baumanni* Stark

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Acroneuria abnormis (Newman)

Perla abnormis Newman (1838)
Acroneuria abnormis: Ricker (1938).

Type locality.— New York, Trenton Falls.

Regional distribution.— IL: Hardin Co., Elizabethtown, 28-30-V-28, 3M, T.H. Frison; Jackson Co., Grand Tower, 2-VI-13, 1F, T.H Frison; Massac Co., Metropolis, 1,4-VI-28, 3M, 1F, T.H. Frison.

Discussion.— Males of this species have broad, triangular hooks, similar to *A. ruralis* (Fig. 245). The female subgenital plate is barely produced over sternum 9 (Stark and Gaufin 1976), and nymphs have dark, nearly concolorous abdominal terga. It has been reported in southern Illinois (Frison 1935; Stark and Gaufin 1976), but no specimens were collected during this study. Due to the difficulty in collecting large rivers, its existence in the Mississippi, Missouri, Ohio, and Arkansas Rivers was not documented. Emergence occurs in May and early June.

Acroneuria evoluta Klapalek

Figs. 16, 17, 24, 44, 247, 254, 255, 270, 271, 276-278, 298

Acroneuria evoluta Klapalek (1909).

Type locality.— Louisiana, New Orleans.

Regional distribution.— Watersheds 1-5, 8, 13, 17, 20, 22, 23, 25, 26, 28, 31, 32, 35, 36, 38, 42-50, 52, 53, 55-57, 65, 66, 68, 69, 71, 72, 74, 80, 81, 83, 85-89, 91-99, 102-104, 106-110, 113-126 (Table 1).

Discussion.— This was the most common *Acroneuria* collected in small to medium sized streams in the region. Nymphs were more frequently collected than those of large river species. The female subgenital plate covers about 1/2 of sternum 9 (Fig. 270), and the male aedeagus has a longitudinal spinule band (Figs. 254, 255). Frison (1942), and Stark and Gaufin (1976) first reported it from the region. Ernst and Stewart (1986) reported this species was univoltine in Oklahoma, and nymphs were common in CPOM. Nymphs were collected from streams that were dry during summer, although repeat collections at some localities did not produce additional specimens, suggesting that their existence in a particular stream may depend on dispersal flights and rainfall. Emergence occurs in May, and adults are present until mid- July.

Acroneuria filicis Frison

Figs. 251-253, 266, 267, 296

Acroneuria filicis Frison (1942).

Type locality.— Kentucky, Pineville.

Regional distribution.— Watersheds 1, 28, 31, 34, 42, 44, 45, 47, 67, 71, 91 (Table 1).

Discussion.— This species is widespread in the region, but was seldom collected in large numbers. Males have narrow, sharply pointed genital hooks (Fig. 251), and the nymph has dark blotches along the posterior margin of each abdominal tergum in addition to dark bands on the anterior edge (Fig. 296). Females exhibit variation in subgenital plate shape (Fig. 267), and are often collected in smaller numbers from the same localities as *A. perplexa.* The region probably represents the western limit of its range, where it occupies large, slow gradient permanent streams. Emergence begins in late May and adults are present up to mid July.

Acroneuria internata (Walker)

Figs. 248, 262, 263, 272, 273, 282

Perla internata Walker (1852).
Acroneuria internata: Claassen (1940).

Type locality.— North America.

Regional distribution.— Watersheds 14, 41, 42, 45, 47, 53, 55, 67, 68, 88, 93, 99, 107, 116, 119 (Table 1).

Discussion.— The straight male hooks (Fig. 248) and the bilobed, flap-like female subgenital plate (Figs. 272, 273) distinguish this species from other *Acroneuria.* The nymphal head pattern has a closed "W", appearing as three separate pale patches near the median ocellus (Fig. 282). It was reported from the region by Illies (1966), and Stark and Gaufin (1976). Our localities probably represent the southwestern limit of its range. It was most common in larger, permanent streams in the Boston Mountain and Central Plateau subregions, nearly 1/2 of which receive inputs from large springs. Nymphs have been reared successfully by feeding them midge larvae (Diptera: Chironomidae) for 4-6 weeks. Emergence occurs from late May through June.

Acroneuria mela Frison
Figs. 250, 256, 257, 268, 269, 283, 295

Acroneuria mela Frison (1942).

Type locality.— Indiana, White River, Petersburg.

Regional distribution.— Watersheds 39, 45, 50, 53, 60, 67, 90, 122 (Table 1).

Discussion.— This species is probably more common than records indicate, because of its presence in large rivers which are difficult to sample. Males have stout genital hooks (Fig. 250), with two oval spinule patches positioned apically on the aedeagus (Figs. 256, 257). Nymphs have dark bands on abdominal terga that may or may not reach the anterior or posterior margins (Fig. 295). Frison (1942), Stark and Stewart (1973a), and Stark and Gaufin (1976) provided regional records, noting its occurrence in large rivers. Its distribution in North America follows the upper Ohio and central Mississippi River valleys, and includes much of the Gulf Coastal Plain. It occurs in lowland streams having bottomland hardwoods in the riparian zone. Adults have been collected during late May and June.

Acroneuria ozarkensis Poulton and Stewart, new species
Figs. 246, 260, 261, 274, 281, 284.

Type Locality.— Arkansas, Searcy County, Buffalo River, Hwy 65, 4.4 km N Silver Hill.

Types.— Holotype M, Allotype F, 8 paratype M, 26 paratype F, 16-VI-85, H.W. Robison. Holotype and allotype deposited in USNM, 1 paratype M and 3 paratype F deposited in UNT Insect Museum, other paratypes depos. in BCP collection. Additional paratypes: MO: Osage Co., Gasconade R., Hwy 89 access, 6.6 km E Rich Fountain, 7-VII-86, BCP.

Regional distribution.— Known only from these two localities.

MALE: (Figs. 246, 260, 261). Macropterous. Length of forewing 22-23 mm, length of body 18-20 mm. Paraprocts relatively broad, similar to *A. evoluta*, curved inward and acute at apex (Fig. 246). Tergum 10 spinule patches separated mesally, tergum 9 spinule patches barely separated and sparse (Fig. 246). Apical lobe of aedeagus encircled with fine, reddish-brown spinules and connected to basal spinule patch (Figs. 260, 261). Basal lobe of aedeagus with a few short, fine hairs dorsally. Abdominal sterna pale, rest of abdomen dark (Fig. 274). Head with posterior margin pale (Fig. 281).

FEMALE: (Figs. 274, 281). Macropterous. Length of forewing 26-28 mm, length of body 22-25 mm. Subgenital plate oval- shaped, evenly rounded, covering 1/2 of sternum 9. Dark brown pigmentation of abdominal terga and pleura extending to edge of subgenital plate (Fig. 274). Head and body coloration similar to male (Fig. 274).

NYMPH: Unknown.

EGG: (Figs. 284a-d). Outline pear-shaped, cross section circular. Collar knob-like. Chorion reticulate in posterior 3/4, anterior 1/4 smooth. Micropyles arranged circumlinearly in posterior third.

Etymology.— This species name is based on the Ozark Mountains where the type series was collected.

Discussion.— This species is similar to *A. flinti* Stark and Gaufin (1976), and may be a member of the *A. flinti* group due to its dark coloration and deep reticulations of the egg (Stark and Gaufin 1976). The females resemble *A. evoluta*, but have contrasting pigmentation on the adult head and abdomen (Figs. 274, 281). Emergence appears similar to other *Acroneuria*, probably beginning in May. Adults of A. *perplexa* and *A. internata* were also collected at the type locality.

Acroneuria perplexa Frison
Figs. 249, 258, 259, 264, 265, 279, 297

Acroneuria perplexa Frison (1937).

Type locality.— Indiana, White River, Petersburg.

Regional distribution.— Watersheds 1, 7, 9, 13, 14, 17-20, 25-27, 31, 36, 37, 39, 41-46, 48, 50, 52-56, 61, 62, 71-74, 77-79, 93, 98, 99, 102-104, 106-110, 115, 117, 122, 123 (Table 1).

Discussion.— This was the most common regional species of *Acroneuria* in larger streams. The male aedeagus has a more or less rectangular apical spinule patch (Figs. 258, 259), and the female subgenital plate is variable (Figs. 264, 265). Nymphs have a continuous pale "W" anterior to the median ocellus (Fig. 279). Stark and Gaufin (1976) reported it from several localities within the region, and our collections indicate that it is widespread in all subregions except the Mississippi Alluvial Plain and Crowleys Ridge. It was found in larger, permanent streams and emerged in May. Adults are present through mid-July.

Attaneuria ruralis (Hagen)
Figs. 23, 245, 275, 280

Perla (Acroneuria) ruralis Hagen (1861).
Acroneuria ruralis: Claassen (1940).
Attaneuria ruralis: Illies (1966).

Type locality.— Missouri, St. Louis.

Regional distribution.—AR: Greene Co., Paragould, 14-VI-58, 1M, collector unknown; Lawrence Co., Black R., Hwy 63, Black Rock, 22-V-57, 1 F, H.H. Ross & H.J. Stannard. IL: Hardin Co., Elizabethtown, 22-VI-27, 1F, T.H. Frison; Jackson Co., Fountain Bluff, 1-VI-13, 1M, T.H. Frison.

Discussion.— This rare species was reported from large rivers in Arkansas, Missouri, Illinois, and Kansas (Stewart and Huggins 1977). Males have broad, triangular hooks, but the spinules on tergum 10 are not arranged in a patch as in *Acroneuria* (Fig. 245). The female has a submarginal tubercle on sternum 8 (Fig. 275). No additional specimens were collected during this study. This species is widespread but is seldom collected in large numbers. Nymphs can be collected by pulling debris from the river bottom or disturbing rocks of riprap upstream from a net. Emergence occurs from mid-May to early July.

Perlesta baumanni Stark
Figs. 318, 320, 327, 333, 337, 340, 352, 354

Perlesta baumanni Stark (1990a).

Type locality.— Arkansas, Scott County, Mill Creek, Y-City.

Regional distribution.— AR: Garland Co., Mid Fk. Saline R., Hwy 7, Iron Spgs Rec Area, 6-VI-84, 1M, 1F, BCP; Logan Co., Chiggar Cr., Hwy 109, Driggs, 13-V-85, 2M, 3 n, BCP; Perry Co: Dry Run Cr., Hwy 7, 13.2 km S Hollis, 11-V-85, reared 3M, 1 n, BCP; Scott Co., Mill Cr., Y-City, 30-IV-72, 3M, 9F, RWB; Big Cedar Cr., Hwy 28, 6.6 km E Big Cedar, 14-V-85, 2M, BCP. OK: Latimer Co., Turkey Cr., Hwy 270, 13-V-72, 3M, 3F, BPS; Leflore Co., Cedar Cr., Hwy 59, 30-IV-72, 1M, 4F, RWB.

Discussion.— This is the only *Perlesta* having wings with a black costal margin (Fig. 320). Stark (1990a) noted the uniformly brown nymphal coloration, and the pale "W" is weak and usually not continuous (Fig. 354). The female sternum 8 is sinuate (Fig. 337), rather than notched as in other *Perlesta*. Four localities in addition to those listed by Stark (1990a) are given above. This species is endemic to the Ouachita subregion and occupies intermittent or dry streams. Emergence begins in late April and continues through early June.

Perlesta browni Stark
Figs. 317, 326, 332, 334, 344, 351, 357

Perlesta browni Stark (1990a).

Type locality.— Oklahoma, Latimer County, Rock Creek, 15.4 km north of Red Oak.

Regional distribution.— Watersheds 1, 14, 16, 18, 31, 33, 34, 37, 47, 55, 56, 61, 73, 74, 90, 101, 104 (Table 1).

The first nymphal description is provided here:

NYMPH: (Fig. 357). General color yellow to pale or light brown. Head mask brown, anterior dark band absent or very weak (Fig. 357), pale "W" absent. Posterior margin of head without brown patches, occiput with setal row. Brown pigment between lateral ocelli and edge of eyes absent. Pronotal disk light brown with scattered yellow areas. Abdomen with numerous intercalary setae each set in brown socket, giving freckled appearance (Fig. 47).

Discussion.— Males of this species have straight, narrowly pointed paraprocts (Fig. 317). The weak brown band anterior to the head mask, although occasionally absent, is separated from the mask, leaving no pale "W" (Fig. 357). This species is endemic to the region, and was most common in larger streams in the Ouachita subregion (Table 2). Emerge occurs from late April through June.

Perlesta cinctipes (Banks)
Figs. 314, 323, 329, 338, 342, 347, 356

Perlesta cinctipes Banks (1905).

Type locality.— Kansas, Pottawatomie County, Onaga.

Regional distribution.— Watersheds 10, 11, 14, 18, 19, 34, 37, 46, 52, 53, 56, 88, 90, 101, 107, 110, 113-115 (Table 1).

Discussion.— This species is separated from other regional *Perlesta* by the banded femora (Fig. 342). The male has evenly curved, long, narrow paraprocts bordered by dark pigmentation (Fig. 314). The spine on the anteroapical margin of the paraprocts is far from the tip (Fig. 329) as in *P. browni*. Adults usually have a pronotal stripe, and nymphs have a continuous pale "W" anterior to the head mask (Fig. 356). In addition to our regional collections, it has been reported from Oklahoma, Kansas, and northern Missouri (Stark 1990a). It was most frequently collected from streams with slower gradients in the Central Plateau, Springfield Plain, Ouachita, and Missouri River border subregions. Based on our collections, this species may be able to withstand moderate levels of organic enrichment. It emerges from mid-May through June.

Perlesta decipiens (Walsh)
Figs. 312, 313, 319, 322, 328, 336, 345, 349

Perlesta decipiens Walsh (1863).

Type locality.— Illinois, Rock Island.

Regional distribution.— Watersheds 2-5, 7, 9, 13-15, 17-23, 25-28, 32, 34, 35, 37-41, 49-55, 58-62, 65, 66, 68, 70, 71, 73-79, 81, 82, 85-91, 93-101, 103-105, 107, 109-111, 113-126 (Table 1).

Discussion.— This was the most common, widespread species of *Perlesta* in the region. Males have bluntly pointed paraprocts that are pigmented on the outer margin (Figs. 312, 313). The entire costal margin of the forewing is yellow (Fig. 319), and the caecum of the extruded male aedeagus is large (Fig. 322). Nymphs of some regional populations have a broken pale band anterior to the head mask, leaving 3 separate pale areas. Nymphs usually have brown pigment between lateral ocelli and inner margin of the eyes (Fig. 358). Snellen and Stewart (1979b) reported the life history of this species, then considered a variant of *P. placida* (Stark 1990a), and found it to survive well in intermittent streams. Emergence begins in mid-May, and adults are present through mid July.

Perlesta fusca Poulton and Stewart, new species
Figs. 47, 315, 321, 324, 330, 339, 341, 346, 353

Type Locality: Arkansas, Newton County, Yardelle Creek,Hwy 123, 4.4 km south of Western Grove.

Types.—Holotype M, Allotype F, 12 paratype M and 7 paratype F, 4-VI-84, BCP. Holotype and allotye deposited in USNM, paratypes deposited in BCP collection.

Regional distribution.— Watersheds 1, 8, 9, 10, 18, 33, 34, 37, 44, 45, 53, 55, 65, 74, 87, 88, 90, 92, 123 (Table 1).

MALE: (Figs. 315, 324, 330). Forewing length 8-9mm, body length 9-11mm. General color brown, some abdominal sterna pale (Fig. 324). Costal margin of wings dark brown to black anteriorly, yellow posteriorly (Fig. 321). Head with ocellar quadrangle dark, lighter brown areas extending to posterior margin of head and laterally to eyes; rest of head yellow (Fig. 346). Brown blotch present on thoracic sterna. Pronotum brown, femora with dorsodistal brown patch reaching tibial articulation (Fig. 341). Paraprocts brown, short and triangular (Fig. 315), and somewhat blunt (Fig. 330), with an anteapical spine (Fig. 330). Sparse sensilla basiconica patch on tergum 10. Penis tube and sac long, caecum weak, lateral sclerites long and slender, patch covers dorsal surface of sac (Fig. 324).

FEMALE: (Figs. 339, 341, 346). Forewing length 10-12mm, body length 12-14mm. Subgenital plate lobes with rounded corners separated by a V-shaped notch (Fig. 339). Forewing, abdomen, and head coloration similar to male.

NYMPH: (Figs. 47, 353). General color brown, lacking contrast except for scattered pale areas. Head mask brown, accessory band 5, anterior to pale "W" uniformly brown (Fig. 353). Posterior margin of head with brown patches. Pronotal disk brown with scattered pale areas. Abdomen with sparse intercalary setae each set in brown socket, giving slight freckled appearance (Fig. 47). Occipital setal row approaches ecdysial suture.

EGG: Outline oval, cross-section circular. Chorion reticulate, collar absent.

Etymology.— The name is derived from the latin word "fuscus", meaning dark or dusky, and refers to the coloration of this species.

Discussion.— This species is similar to *P. baumanni* because of the dark coloration and broad male paraprocts. It is endemic to the region and was most common in the Arkansas River Valley, Ouachita, and Boston Mountain subregions (Table 1). It was also collected from a few small, Gulf- Coastal Plain streams. Adults were collected by sweeping vegetation at streams that were reduced to standing pools by late spring months. Emergence occurs from late April to early June.

Perlesta placida (Hagen)

Perla placida Hagen (1861).
Chloroperla virginica: Banks (1898).
Perlesta placida: Stark (1990a).

Type locality.— Washington, District of Columbia.

Regional distribution.— Unknown from the region.

Discussion.— The genus *Perlesta* has been recently revised (Stark 1990a). Specimens previously identified as *P. placida*, including those examined from museums during this study, contained numerous species. Stark (1990a) noted the distribution of *P. placida* as extending into Louisiana and Mississippi. Regional collections did not contain *P. placida*, but it is mentioned here because of the possibility of its occurrence in the region.

Perlesta shubuta Stark
Figs. 316, 325, 331, 335, 343, 348, 350, 355

Perlesta shubuta Stark (1990a).

Type locality.— Mississippi, Simpson County, Mill Creek.

Regional distribution.— Watersheds 26, 47, 52, 68, 85, 89, 91, 93, 99, 100, 124, 125 (Table 1).

Discussion.— Nymphs of this species are distinguished from other *Perlesta* by the speckled head mask, which contains no dark pigmentation (Fig. 355). Adults are similar to *P. decipiens*, but both species were reared and nymphs can easily be separated. Stark (1990a) described this species from Mississippi. Based on differences between this description and our material, and the fact that eggs from regional populations were not available, our specimens are tentatively placed under *P. shubuta*, and may represent another undescribed species. Speckled nymphs were reared from larger, permanent streams, and is apparently the only regional *Perlesta* restricted to these conditions. Emergence occurs later than other *Perlesta* species, probably during June and July.

Perlinella drymo (Newman)
Figs. 360, 361, 363, 366

Isogenus drymo Newman (1839).
Perlinella drymo: Claasen (1940).

Type locality.— Georgia.

Regional distribution.— Watersheds 4, 14, 21, 24, 27, 34, 37, 38, 41, 45, 47, 48, 50, 52, 53, 60, 62, 64-70, 72, 76, 80, 81, 83, 85, 87-91, 93, 94, 96, 101, 102, 104, 106-109, 111, 115-117, 119, 120, 125 (Table 1).

Discussion.— This is the largest regional *Perlinella*, and is separated from *P. ephyre* by pronotum coloration, and stout male paraprocts (Figs. 360, 366). Nymphs are brown and usually have a "W" anterior to ocelli (Fig. 363). Previous records include Illinois and Arkansas (Illies 1966), Oklahoma (Stark and Stewart 1973a; Ernst and Stewart 1985b), and Missouri (Kondratieff et al. 1988). The nymphs were rarely collected in large numbers, and appeared to prefer portions of riffles with slower gradients, often occurring in organic debris at stream margins. *P. drymo* is one of three species of Perlidae found on Crowley's Ridge, where it occurs in large numbers at some localities. It was found in all subregions except the Mississippi Alluvial Plain, in both permanent and temporary streams. Emergence is the earliest of regional perlids, and occurs from mid-March to early May.

Perlinella ephyre (Newman)

Figs. 359, 362, 364, 365

Chloroperla ephyre Newman (1839).
Atoperla ephyre: Claassen (1940).
Perlinella ephyre: Zwick (1971).

Type locality.— Georgia.

Regional distribution.— Watersheds 2-4, 14, 17, 23, 25, 26, 32, 36, 38, 39, 42, 45, 47-49, 52, 53, 55, 65-68, 71, 72, 85, 87, 91, 93, 95, 99, 100, 103, 104, 107, 109, 115-117, 119, 120, 124, 125 (Table 1).

Discussion.— Males are distinguished from *P. drymo* by the narrow paraprocts and the single mesal pronotal stripe (Figs. 359, 365). Nymphs lack dark pigmentation, suggesting a hyporheic existance (Stanford and Gaufin 1974). Nymphs have two well-developed ocelli (Fig. 363), and are rare when compared to the abundance of adults collected from light traps. Illies (1966) noted this species from Arkansas, Ernst and Stewart (1985b) from Oklahoma, and Kondratieff et al. (1988) from Missouri. The region probably represents the western limit of its range, where it was commonly collected from mountainous subregions and the Gulf Coastal Plain (Table 2). Nymphs occur in fine gravel in slow, deep portions of riffles, and were often observed emerging on water willow. Emergence begins in May and adults are present through July.

Neoperla carlsoni Stark and Baumann

Figs. 215, 220, 225, 233, 237

Neoperla carlsoni Stark and Baumann (1978).

Type locality.— Florida, Gadsden County, Rocky Comfort Creek, Quincy.

Regional distribution.— AR: Crawford Co., Clear Cr., Hwy 282, 23-VII-84, 1F, HWR; Logan Co., Petit Jean R., 3.3 km W Magazine, 2-VII-84, 6M, 3F, BCP; Petit Jean R. Hwy 23, 2.2 km S. Booneville, 11-VII-81, 2M, 8F, HWR; Scott Co., Mill Cr., Y-City, 29-VI-80, 13M, 28F, HWR; Sebastian Co., Vache Grasse Cr., Hwy 22 1.1 km E Central City, 21-VI-84, 5M, 1F, HWR; Sevier Co., Saline R, Hwy 24, E Lockesburg, 26-VII-82, 2M, 2F, HWR & Koym. MO: Dallas Co., Niangua R., Moon Valley Access, 5.5 km E Windyville, 6-VII-86, 1F, BCP.

Discussion.— This species is separated from other regional *Neoperla* by the short, triangular spermatheca of females (Fig. 233), and differences in femoral pigmentation of males (Fig. 237). It is a member of the "*choctaw*" complex (Stark and Baumann 1978; Ernst et al. 1986). The nymph is unknown. Oklahoma specimens reported by Stark and Baumann (1978) were confirmed as *N. harpi* Ernst and Stewart (Ernst et al. 1986). This species is found west to Texas, and Missouri probably represents the northwestern limit of its range. Eggs of regional populations exhibit variation from paratypes collected in South Carolina (Ernst et al. 1986). It is present in slow moving, murky streams, some with intermittent flow. The emergence period is similar to that of *N. choctaw*, from late June through July.

Neoperla catharae Stark and Baumann

Figs. 214, 217, 228, 235, 243

Neoperla catharae Stark and Baumann (1978).

Type locality.— Arkansas, Randolph County, Jane's Creek.

Regional distribution.— Watersheds 4, 17, 36, 45, 46, 48, 49, 53, 61, 63, 66, 68, 85, 91, 95, 102, 110, 115, 122, 125 (Table 1).

The first nymphal description is provided here:

NYMPH: (Fig. 243). General color pale yellow with dark brown pigmentation. Transverse band between antennal bases wide, narrowing mesally, posterior margin sinuate. Ocellar pigmentation extends posterolaterally to hind margin of head. Pronotal ring brown, lateral and posterior margins pale.

Discussion.— This is the most common *Neoperla* in the "choctaw" complex. Males have straight genital hooks (Fig. 214), and the female spermatheca is curved, narrowing apically (Fig. 235). Nymphs were usually of smaller size than most other regional *Neoperla*. In addition to previously reported regional localities (Stark and Baumann 1978; Ernst et al. 1986), our collections include the first from Missouri. Regional populations are disjunct from more eastern populations in Ohio. Most regional records were from the Ouachita, Central Plateau, and Curtois Hills subregions, where it was collected in permanent streams (Table 2). Emergence begins later than other summer emerging species, and adults are present until early October.

Neoperla choctaw Stark and Baumann
Figs. 213, 218, 229, 234, 238, 240

Neoperla choctaw Stark and Baumann (1978).

Type locality.— Oklahoma, Latimer County, Red Oak Creek, Denman.

Regional distribution.— Watersheds 19, 29, 34, 37, 48, 52, 69, 80, 88, 90, 108 (Table 1).

The first description of the nymph is provided below:

NYMPH: (Fig. 240). General color pale yellow with dark brown pigmentation. Transverse band between antennal bases medium wide, posterior margin sinuate, pigmentation extends to anterolateral corners of head, and labrum margin. Brown patch from ocelli to posterior margin of head. Pronotum with brown ring, yellow on margin of posterolateral corners. Femora with silky, brown hairs and short, stout spinules. Femora and tibia with outer fringe of long, white hairs.

Discussion.— This is one of three regional "choctaw" group species, which are all characterized by spines on the outer surface of the male aedeagal tube (Figs. 217, 218, 220), very short female spermatheca (Figs. 233-235), and no anterior indentation on female sternum 8 (Figs. 225, 228, 229). Femur pigmentation is used to separate males of this species from *N. carlsoni* (Figs. 237, 238), and females are separated by spermathecal or egg characters. Records listed above include the first reports in Missouri. This species was previously reported from Arkansas and Oklahoma (Stark and Baumann 1978; Ernst et al. 1986). West Virginia populations are apparently disjunct from those in the region. Regionally, it was most common in the Gulf Coastal Plain, Ouachita, and Missouri River border subregions. Emergence is from late June through July.

Neoperla clymene (Newman)

Chloroperla clymene Newman (1839).
Neoperla clymene: Claassen (1940).

Type locality.— Georgia.

Regional distribution.— Unknown from the region. Localities nearest to the region include: OK: Bryan Co., Blue River (Stark and Baumann 1978), and the Kansas River near Lawrence, KS (BCP, unpublished data).

Discussion.— This species was considered common from the region, based on identifications by B. P. Stark (Ernst et al. 1986). Examination of the type specimen of *N. clymene*, revealed that *N. clymene* and *N. stewarti* as reported in Ernst et al. (1986) were two different species, *N. falayah* & *N. osage*, respectively (Stark and Lentz 1988). The Benton County, Arkansas specimens listed by Stark and Baumann (1978) as *N. freytagi* were confirmed as *N. harpi* (Ernst et al. 1986). Further clarification is provided in Stark (1990b), and at present, *N. freytagi* and *N. clymene* are not known from the region.

Neoperla falayah Stark and Lentz
Figs. 211, 222, 223, 232, 239

Neoperla falayah Stark and Lentz (1988).

Type locality.— Oklahoma, Delaware County, Battle Branch.

Regional distribution.— Watersheds 1, 2, 4, 8, 13, 14, 17, 19, 22, 23, 25, 26, 31, 33, 36, 39, 41, 42, 45, 46, 48, 49, 52, 53, 55, 56, 61, 62, 65-67, 71, 72, 74, 76-78, 83-86, 89, 91, 93, 96, 97, 99, 100, 102-104, 108, 109, 110, 115-117, 120-123, 125 (Table 1).

The first description of the nymph is provided here:

NYMPH: (Fig. 240). General color pale yellow with dark brown pigmentation. Transverse hand between anterior edges of antennal bases narrow, posterior margin sinuate, pigmentation absent from antennal bases, or at most, touching their anterior margin. Dark pigmentation present between ocellar area and occiput. Pronotum with brown ring, lateral and posterior margins yellow. Tibiae and femora with thick, brown hairs and short, stout brown spinules.

Discussion.— This common *Neoperla* is one of 4 regional "*clymene*" group species (Stark and Baumann 1978), which all lack spines on the outside surface of the male aedeagal tube (Figs. 216, 219, 221, 222), and have an anterior indentation on female sternum 8 (Figs. 223, 224, 226, 227). This anterior indentation is V-shaped in *N. falayah*, and the spermatheca is coiled at least 1 1/2 times in-situ (Fig. 232). The apex of the male aedeagus, which is visible through the aedeagal tube, has several rows of small, dense spines, unlike the larger spines of other regional species in the "*clymene*" group (Fig. 222). This species is only known from the Ozark-Ouachita region, and is limited to permanent streams (Table 2). Emergence is the earliest of regional *Neoperla*, with adults present from early May through early July.

Neoperla harpi Ernst and Stewart
Figs. 210, 221, 224, 230, 241

Neoperla harpi Ernst et al. (1986).

Type locality.— Oklahoma, Delaware County, Battle Branch.

Regional distribution.— Watersheds 1, 2, 4, 8, 13, 14, 19, 21, 23, 25, 31, 34, 36, 38, 42-46, 48, 49, 53-57, 61-69, 71, 74, 77-80, 83, 85, 88, 89, 92, 100-102, 104, 108, 110, 116, 120, 124, 125 (Table 1).

The first description of the nymph is provided here:

NYMPH: (Fig. 241). General color pale yellow with brown pigmentation. Transverse band between antennal bases wide laterally, narrowing medially. Brown stripe from ocelli to anterior margin of eyes, closed yellow region anterior to ocelli. Pronotum with brown ring, yellow on lateral and posterolateral margins. Tibiae and femora with thick, brown hairs and short, stout, brown spinules.

Discussion.— This species is distinguished by the medium- length male aedeagal tube (Fig. 221) and the female spermatheca with serrations along the spinule margin (Fig. 230). Nymphs are the most easily recognized of all regional *Neoperla*, with a band of pigmentation extending diagonally from the ocelli (Fig. 241). This species is endemic to the region, and was collected from all subregions except Crowley's Ridge and the Mississippi Alluvial Plain. Like *N. osage*, it occurs most commonly in permanent streams. Emergence begins in mid-June, and adults are present through September.

Neoperla osage Stark and Lentz

Figs. 209, 219, 227, 231, 242

Neoperla osage Stark and Lentz (1988).

Type locality.— Arkansas, Washington County, Devils Den State Park.

Regional distribution.— Watersheds 2-4, 14, 17, 18, 23, 28, 31, 35, 36, 38, 39, 44-46, 48, 49, 52, 55, 56, 61, 81, 83, 85, 87-89, 95, 96, 99, 102, 103, 108, 110, 111, 121-125 (Table 1).

The first description of the nymph is given here:

NYMPH: (Fig. 242). General color pale yellow with red-brown pigmentation. Transverse band between antennal bases wide, posterior margin lighter and near anterior margin of eyes. Ocellar pigmentation extends laterally along occipital ridge, and posteriorly to margin of head. Pronotum with brown ring, lateral and posterior margins pale.

Discussion.— Males have short, straight genital hooks (Fig. 209), and a short, stout aedeagal tube (Fig. 219). The female spermatheca is sclerotized for 3/4 its width, and is truncated apically at the tip (Fig. 231). This species was originally reported as *N. stewarti* (Stark and Lentz 1988), which is presently unknown from the region. *N. osage* is endemic to the region, but was also collected from large rivers of the Gulf Coastal Plain. Emergence extends from late May to late August.

Neoperla robisoni Poulton and Stewart

Figs. 212, 216, 226, 236, 244

Neoperla robisoni Ernst et al. (1986).

Type locality.— Arkansas, Ouachita River - Little Missouri River confluence, Tates Bluff.

Regional distribution.— Watersheds 14, 15, 20, 33, 39, 44, 48, 52, 53, 57, 58, 60-63, 66-68, 71, 91, 93, 99, 107, 119 (Table 1).

The first description of the nymph is provided below:

NYMPH: (Fig. 244). General color pale yellow with dark brown pigmentation. Transverse band between antennal bases of medium width, narrower laterally, posterior margin sinuate. Pigmentation absent from antennal bases, or present, at most on their anterior edge. Ocellar pigmentation extends diagonally to antennae, and posteriorly to hind margin of head. Pronotal ring brown, pigmentation extending posteriorly along pronotal suture. Lateral and posterior pronotal margins pale.

Discussion.— Males of this species have a relatively long aedeagal tube, with ventral bulb equal to 1/5 - 1/7 total tube length (Fig. 216). The female spermatheca has striations with a narrowed, cone-shaped apex (Fig. 236). This species is nearly restricted to large, permanent rivers, and is present in the Gulf Coastal Plain (Table 2). Numerous male specimens from the Gasconade River, Missouri contained eggs in their abdomens. These had an elastic, transparent coating and a milky-white center with a dark spot. These eggs did not resemble those of *Neoperla*, and presumably belong to a parasitoid, representing one of the first reports of such an occurrence in Plecoptera. This species emerges from early June through late July.

Agnetina capitata (Pictet)

Figs. 286, 290, 294, 299, 301, 304, 306

Perla capitata Pictet (1841).
Phasganophora capitata: Illies (1966).
Agnetina capitata: Zwick (1984).

Type locality.— USA.

Regional distribution.— Watersheds 28, 36, 38, 68, 92, 97, 102, 103, 116, 120, 124 (Table 1).

Discussion.— This species differs from *A. flavescens* by the shape of the male genital hooks (Figs. 286, 290), pigmentation on the head and female sterna 8 & 9 (Figs. 294, 304), and the banding on nymphal terga (Fig. 299). Nymphs often lack dark pigment on tergum 10 (Stark 1986). It was listed from Illinois and Kansas by Illies (1966) under the name *Phasganophora capitata*, and Stark (1986) reported one Missouri locality. This species is distributed further north than *A. flavescens*, and regional populations are disjunct from those in northern and eastern North America. About 85% of regional localities had a small yearly water temperature fluctuation (Fig. 3) due to inputs from large springs, making this species an indicator of spring streams. It was most commonly collected in the White River and Springfield Plateau subregions. Emergence begins in May and continues through June.

Agnetina flavescens (Walsh)

Figs. 41, 285, 289, 293, 300, 302, 303, 305

Perla flavescens Walsh (1862).
Agnetina flavescens: Stark (1986).

Type locality.— Illinois, Rock Island.

Regional distribution.— Watersheds 1, 3, 4, 13-15, 17, 25, 28, 36, 42, 45, 48, 55-57, 61, 66, 74, 81, 85, 89, 91-93, 96, 97, 99, 100, 102-104, 108, 111, 115-118, 120, 122-125 (Table 1).

Discussion.— This is the most common species of *Agnetina* in the region. Ernst and Stewart (1986) collected this species in Oklahoma, and reported it as *Phasgonophora capitata*. They found it to have a prolonged emergence during summer. Stark (1986) and Stark et al. (1986) provided distributional records for all states within the region. It was frequently collected in abundance from many subregions, but it was not collected in the Illinois Ozarks. It is confined to permanent streams, and adults were found throughout the summer, which suggested a differential hatching of eggs (Ernst and Stewart 1985b).

Paragnetina kansensis (Banks)

Figs. 288, 292, 309, 311

Perla kansensis Banks (1905).
Togoperla kansensis: Ricker (1945).
Paragnetina kansensis: Ricker (1949).

Type locality.— Kansas.

Regional distribution.— Watersheds 14, 39, 47, 52, 67, 68, 124 (Table 1).

Discussion.— This species is distinguished from *P. media* by the absence of an overlapping lobe on male tergum 5 (Fig. 288), and the female sternum 8 which is produced over 1/2 of sternum 9 (Fig. 292). Nymphs have a diagonal pale band extending from eyes to the posterior margin of the head, which may be interrupted by brown pigment at the occipital ridge (Fig. 309). It is widespread in the region (Illies 1966; Stewart and Huggins 1977; Stark and Szczytko 1981), but it was not collected in abundance. Our records suggest that it is more common than *P. media* in large, warm rivers not fed by springs. Emergence begins in early May and continues through mid-June.

Paragnetina media (Walker)

Figs. 22, 40, 45, 287, 291, 307, 308, 310

Perla media Walker (1852).
Togoperla media: Claassen (1940).
Paragnetina media: Ricker (1964).

Type locality.— Canada, Ontario, Albany River, St. Martins Falls.

Regional distribution.— Watersheds 3, 23, 38, 47, 53, 68, 72, 93, 99, 100, 109, 121, 124 (Table 1).

Discussion.— This species is distinguished from *P. kansensis* by male tergum 5 that overlaps tergum 6 (Fig. 287), and by the small bilobed female subgenital plate (Fig. 291). There are two different nymph phases in the region: 1) light phase, with large pale blotches adjacent to ocelli and occipital ridge (Fig. 307), and 2) dark phase, with a uniformly brown head and small pale patches (Fig. 308). Both have been reared, and eggs had much shorter collars than those shown in Stark and Szczytko (1981). Drumming signals from females of regional populations vary from those of more northern populations (Maketon and Stewart 1988). Regional populations probably represent the southwestern limit of its distribution, and are separated from northern portions of its range where it is more common. Stark and Szczytko (1981) reported one Missouri locality, and museum collections included some records. Our collections from large springs include Blanchard Springs (Sylamore Creek), and Mammoth Springs (Spring River) in Arkansas, and the North Fork White River, Current River, and Jacks Fork River drainages in Missouri (Table 1). About 90% of localities were from permanently flowing streams that contained flow from springs, suggesting it may be an indicator of these conditions. The emergence period is late April through May.

Family Perlodidae

This family has 14 regional species, which emerge in the spring. Adults lack conspicuous gill remnants, and the forewing has a cubito-anal crossvien separated from the anal cell by more than its own length (Fig. 8). The robust nymphs have wingpads generally parallel to the body axis, but in mature nymphs, the inner margins of the hind wingpads are more divergent than those of the front wingpads. Adult *Isoperla* Banks are smaller than *Hydroperla* Frison, *Helopicus* Ricker, and *Clioperla* Needham and Claassen, and their nymphs have well-defined color patterns and are often easier to identify than adults. Exuviae can also be identified with the nymphal key below. Male *Isoperla* can be more easily identified if the fleshy aedeagus is field-extruded at the time of collection (Szczytko and Stewart 1979). Pending a revision of the eastern *Isoperla* species (S. W. Szczytko, pers. comm.), some fine details of the ultrastructure of the aedeagus are not included in the following key. Sweeping vegetation was an effective collecting technique for adults, but large species were cryptic, and were often found under streamside rocks. Emergence of some *Isoperla* is known to coincide with appearance of buds or blossoms of certain plants (Ernst and Stewart 1985b). Nymphs are mostly carnivorous, and often inhabit leaf packs due to the presence of their food items. *Isoperla mohri* is known to be a herbivore-detritivore (Feminella and Stewart 1986), and some species may switch food habits in later instars (Fuller and Stewart 1979), becoming carnivorous during the last month of growth.

Key to Genera and Species of Perlodidae

Males and Females

1. Male tergum 10 deeply cleft (Figs. 371, 372); paraprocts not modified into recurved hooks; gill remnants on submentum......... **2**
   Male tergum 10 entire (Fig. 369); paraprocts modified into recurved hooks (Figs. 397-406); submental gill remnants absent....... **7**
2. Males **3**
   Females........ **5**
3. Epiproct with lateral stylets (Fig. 371)........ ***Hydroperla*** Frison **4**
   Epiproct without lateral stylets (Fig. 372)........ ***Helopicus nalatus*** (Frison)
4. Epiproct with decurved hook (Fig. 368), broader at tip than at its base........ ***H. crosbyi*** (Needham and Claassen)
   Epiproct without decurved hook (Fig. 377), usually tapered........ ***H. fugitans*** (Needham and Claassen)
5. Female subgenital plate bluntly pointed (Fig. 376); margins of eyes with dark pigment along nearly entire margin (Fig. 383)........ ***H. fugitans*** (Needham and Claassen)
   Female subgenital plate rounded (Fig. 375); dark pigment along eye margins absent or restricted to anterior margin (Figs. 381, 382) **6**
6. Female subgenital plate mostly dark, extending beyond middle of sternum 9 (Fig. 374)........ ***H. nalatus*** (Frison)
   Female subgenital plate with 2 pale areas, not reaching past middle of sternum 9 (Fig. 375)........ ***H. crosbyi*** (Needham and Claassen)
7. Male with a pair of ridges on posterior margin of tergum 10 (Fig. 369); female with subgenital plate barely overlapping sternum 9 (Fig. 373); forewing length usually > 12mm........ ***Clioperla clio*** (Newman)
   Male tergum 10 without ridges; female subgenital plate overlaps at least 1/4 of sternum 9, and forewing length usually < 12 mm (Fig. 407-416)........ ***Isoperla*** Banks **8**
8. Dark pigment on head absent, or connecting ocelli only (Figs. 417, 420, 423)........ **9**
   Dark pigment on head present in ocellar region and elsewhere (teneral adults may be pale)(Figs. 418, 419, 421, 422, 424-426)..... **11**
9. Dark pigment absent from head, except for minute spots lateral to ocelli (Fig. 423); male aedeagus with patch-like process and a single fleshy, pointed lobe (Fig. 388); female subgenital plate short, barely overlapping sternum 9 (Fig. 412)......... ***I. decepta*** Frison
   Dark pigment connecting ocelli (Figs. 417, 420); male aedeagus without patch-like process (Figs. 387, 392); female subgenital plate usually overlapping at least 1/3 of sternum 9 (Figs. 409, 410)........ **10**
10. Aedeagus with sclerotized, basoventral tooth (Fig. 387); dark pigment of male vescicle extends anteriorly to overlap 2/3 of sternum 8 (Fig. 387); pronotum rugosities surrounded by dark pigment (Fig. 420)........ ***I. dicala*** Frison
    Aedeagus without sclerotized teeth (Fig. 392); dark pigment of male vescicle extends anteriorly, covering 1/2 of or less of sternum 8 (Fig. 392); pronotum rugosities without dark pigment (Fig. 417)........ ***I. bilineata*** (Say)
11. Male aedeagus with patch-like indentation bearing teeth (Figs. 391, 395); head with dark pigmented lobes extending from posterior edges of lateral ocelli towards center of eyes (Figs. 422, 425); female subgenital plate rounded........ **12**
    Male aedeagus without patch-like indentation bearing teeth, but may have a pair of sclerotized basoventral teeth (Figs. 394, 396); head with dark pigmented lobes extending from lateral ocelli towards posterior margin of eye or head (Figs. 418, 424, 426), or this dark pigment absent (Figs. 419, 421); female subgenital plate rounded or pointed........ **13**
12. Aedeagal patch with a single row of 6-8 sclerotized teeth in an indented patch (Fig. 395); dark pigment along anterolateral margins of head weak or absent (Fig. 425); abdomen more or less uniformly pale; female subgenital plate evenly rounded (Fig. 407) .... ***I. szczytkoi*** Poulton and Stewart
    Aedeagal patch with 2 rows of numerous sclerotized teeth in an indented patch (Fig. 391); anterolateral margins of head with dark pigment (Fig. 422); abdomen mostly dark; female subgenital plate often slightly indented (Fig. 414)........ ***I. mohri*** Frison
13. Male aedeagus with oval lobe bearing numerous spinulae (Fig. 397); head lacking dark pigment except oceller triangle and anterior to median ocellus (Fig. 421); female subgenital plate triangular, evenly tapered (Fig. 415) .... ***I. burksi*** Frison
    Male aedeagus without oval lobe bearing numerous spinulae (Figs. 402, 403, 405); head with dark pigment adjacent to eyes or antennae (Figs. 418, 419, 424, 426); female subgenital plate rounded, or if pointed, not evenly tapered (Figs. 411, 413)........ **14**
14. Male aedeagus with pair of fleshy lobes each bearing a sclerotized tooth (Figs. 394, 396); head with dark pigment posterior to eyes, but lacking dark pigment connecting lateral ocelli and posterior margin of head (Figs. 418, 419); female subgenital plate rounded or slightly indented (Figs. 408, 416)........ **15**
    Male aedeagus without a pair of lobes bearing sclerotized teeth (Fig. 389, 390); dark pigment posterior to eyes absent (Fig. 426), or if present, weaker than that of ocellar triangle (Fig. 424); dark pigment sometimes connecting lateral ocelli and posterior margin of head (Fig. 426); female subgenital plate at least slightly pointed (Figs. 411, 413)........ **16**

15. Male vesicle about as long as wide (Fig. 394); ocellar triangle and posterior margin of eye usually connected with dark pigment (Fig. 418); ocellar triangle usually not closed (Fig. 418); female subgenital plate rounded (Fig. 416) .... ***I. namata*** Frison
    Male vescicle wider than long (Fig. 396); dark pigment of ocellar triangle and posterior margin of eye separated by pale areas (Fig. 419); ocellar triangle with pale spot completely surrounded by dark pigment (Fig. 419); female subgenital plate sometimes slightly notched (Fig. 408)........ ***I. signata*** (Banks)
16. Male aedeaus lacking numerous fleshy lobes (Fig. 390, 398); dark pigment nearly absent from anterolateral corners of head (Fig. 426); female subgenital plate usually pointed (Fig. 411)........ ***I. coushatta*** Szczytko and Stewart
    Male aedeagus with numerous fleshy lobes (Figs. 389, 404); dark pigment present along entire anterolateral margin of head (Fig. 424); female subgenital plate rounded or slightly pointed (Fig. 413)........ ***I. ouachita*** Stark and Stewart

Nymphs

1. Submental gills present (Fig. 27); pigment stripes on abdominal terga, if present, transverse with dark pigment along anterior margin **2**
   Submental gills absent; pigment stripes on abdominal terga, if present, usually longitudinal (Figs. 440, 441, 444, 445-449), or if transverse, dark pigment is along posterior margin (Fig. 442, 443)........ **3**
2. Dark pigment along posterior margin of head usually absent; head mask between antennal bases straight (Fig. 378) .... ***Helopicus nalatus*** (Frison)
   Dark pigment present along posterior margin of head; head mask between antennal bases sinuate (Figs. 379, 380) .... ***Hydroperla*** Frison **4**
3. Dark pigment on head a rectangular outline (Figs. 385, 386); abdominal terga uniformly brown, sometimes with pale spots .... ***Clioperla clio*** (Newman)
   Dark pigment on head not a rectangular outline (Figs. 427-435, 437-439); abdominal terga with pigment contrast (Figs. 440-449) .... ***Isoperla*** Banks.. **5**
4. Dark band across anterior margin of head continuous (Fig. 379); pronotum with narrow pale margin (Fig. 379) .... ***H. crosbyi*** (Needham and Claassen)
   Dark band across anterior margin of head broken into 2 spots (Fig. 380); pronotum with irregular, wide pale margin (Fig. 380) .... ***H. fugitans*** (Needham and Claassen)
5. Abdominal terga with transverse bands (Fig. 442, 443)........ **6**
   Abdominal terga with longitudinal bands, or dark blotches on terga give abdomen a striped appearance (Fig. 440, 441, 444-448).... **7**
6. Lacinia with two elongated teeth and very few accessory spines (Fig. 452); pale area anterior to median ocellus open (Fig. 438) .... ***I. burksi*** Frison
   Lacinia with two teeth and a row of several spines (Fig. 451); pale area anterior to median ocellus usually closed (Fig. 434........ ***I. signata*** (Banks)
7. Lacinia with 1-2 short, blunt teeth (Fig. 458); abdominal sterna with paired spots (Fig. 436); abdominal terga with blotches near posterior margin (Fig. 446)........ ***I. decepta*** Frison
   Lacinia with 1-2 prominent teeth (Figs. 450, 452, 453, 454, 459); paired spots absent from abdominal sterna; abdominal terga with longitudinal bands (Figs. 440, 441, 444, 445, 447, 448) **8**
8. Lacinia with 2 teeth, the second usually shorter than the first (in *I. szczytkoi*, second tooth barely visible) (Figs. 450, 454, 456, 457, 459) **9**
   Lacinia with 1 tooth (Figs. 453, 455)........ **13**
9. Abdominal terga with diagonal bands, pointing inward posteriorly (Fig. 444); lacinia with second tooth short, barely visible (Fig. 456) .... ***I. szczytkoi*** Poulton and Stewart
   Abdominal terga with straight bands (Figs. 441, 447, 448); lacinia with second tooth prominent (Figs. 450, 454, 457, 459)....... **10**
10. Dark spots on abdominal terga absent, or limited to 2 laterally (Figs. 441, 449); dark bands on abdominal terga with narrow pale borders (Figs. 441, 449); ocellar triangle dark, closed, and with a small pale spot (Figs. 428, 439) **11**
    Dark spots present on abdominal terga (Figs. 447, 448); dark bands on abdominal terga with (Fig. 447) or without (Fig. 448) narrow pale borders, but ocellar triangle open or mostly pale (Figs. 427, 432, 433)........ **12**
11. Pale patches near anterolateral corners of head closed (Fig. 439); dark pigment present along pronotal suture (Fig. 439)........ ***I. dicala*** Frison
    Pale patches near anterolateral corners of head continuous with other pale areas (Fig. 428); dark pigment usually absent along pronotal suture........ ***I. coushatta*** Szczytko and Stewart
12. Dark pigment continuous between lateral ocelli and posterior margin of head (Fig. 427); ocellar triangle pale, closed (Fig. 427); dark bands on abdominal terga without narrow pale borders (Fig. 448) .... ***I. bilineata*** (Say)
    Dark pigment between lateral ocelli and posterior margin of head not continuous (Figs. 432, 433); ocellar triangle open, connected to other pale areas (Fig. 432, 433); dark bands on abdominal terga with narrow pale borders (Fig. 447)........ ***I. namata*** Frison
13. Median longitudinal dark bands of abdominal terga narrow (Fig. 440); lacinia broad, triangular, tooth as short as spinules (Fig. 453) .... ***I. ouachita*** Stark and Stewart
    Median longitudinal dark bands of abdominal terga wide (Fig. 445); lacinia narrow, tooth longer than spinules (Fig. 455)........ ***I. mohri*** Frison

Clioperla clio (Newman)
Figs. 369, 370, 373, 384-386

Isogenus clio Newman (1839).
Isoperla clio: Frison (1935).
Clioperla clio: Szczytko and Stewart (1981).

Type locality.— Georgia.

Regional distribution.— Watersheds 1-126 (Table 1).

Discussion.— Szczytko and Stewart (1981) recently re-evaluated Clioperla Needham and Claassen, and recognized that it was different from *Isoperla*. Male tergum 10 has a pair of posterior ridges and hooks (Fig. 369), and the aedeagal spines are large and dense (Fig. 370). The female subgenital plate is lip-like and barely covers sternum 9 (Fig. 373). Mature nymphs collected from some localities in eastern Missouri have darker head pigmentation (Fig. 386). *Clioperla clio* was the most widespread stonefly species within the region. It was collected in a wide variety of stream types from every watershed, including streams which had no other stoneflies. Adults were secretive and seldomly collected in large numbers. Nymphs occured in a few Missouri streams which recieved mine drainage for many years. Poulton et al. (1989) reported this species had a high tolerance for chromium, and it was collected in streams with intense organic pollution in agricultural areas of the Gulf Coastal Plain and Springfield Plateau. The region is probably the western limit of its range, where it emerges from late March through April.

Isoperla bilineata (Say)
Figs. 392, 400, 409, 417, 427, 448, 459

Sialis bilineata Say (1823).
Isoperla bilineata: Claassen (1940).

Type locality.— Ohio, Ohio River, Cincinnati.

Regional distribution.— Watersheds 88, 89, 106, 107 (Table 1).

Discussion.— This is the type species for *Isoperla* (Szczytko and Stewart 1978) and head coloration is reduced to light brown pigmentation connecting the ocelli (Fig. 417). The male aedeagus is entirely membranous (Fig. 392), and the female subgenital plate is more pointed than *I. dicala* (Fig. 409). It was reported in southern Illinois from the Mississippi and Ohio Rivers, and in large Kansas rivers (Stewart and Huggins 1975), but was not formerly listed from Missouri. Nymphs were taken in large numbers from stomachs of Shovelnose Sturgeon [*Scaphirhynchus platorynchus* (Rafinesque)](Linden Trial, pers. data), and we have collected large numbers with a black-light from the Missouri River. This species may also be present in the Arkansas River (Roland McDaniel, pers. corresp.). Regionally, it is confined to large rivers, and emergence occurs during May and June.

Isoperla burksi Frison
Figs. 393, 397, 415, 421, 438, 443, 452

Isoperla burksi Frison (1942).

Type locality.— Illinois, Pope County, Lusk Creek, Eddyville.

Regional distribution.— Watersheds 1, 8, 9, 19, 25, 35, 42, 43, 45, 57, 89, 90, 104, 106, 126 (Table 1).

Discussion.— The aedeagus of this species has a bulbous lobe with dense spines (Fig. 397). Adults are light in color and are similar to *I. bilineata*. Nymphs of this species and *I. signata* are the only 2 regional *Isoperla* which have transverse bands on abdominal terga (Fig. 443). It was first reported in Illinois (Frison 1942) but was not reported west of the Mississippi River before this study. Stark et al. (1986) reported it in Arkansas based on our collections in progress. It was collected from one Missouri locality and a few Oklahoma localities, and is most common in the Ouachita and Boston Mountain subregions. About 95% of the localities in this study were from permanent streams (Table 2). Emergence occurs from late March through April.

Isoperla coushatta Szczytko and Stewart
Figs. 390, 398, 411, 426, 428, 441, 457

Isoperla coushatta Szczytko and Stewart (1977).

Type locality.— Texas, Anderson County, Saddler Creek.

Regional distribution.— Watersheds 12, 15, 29, 30, 51, 52, 58, 62, 64, 70, 75 (Table 1).

Discussion.— Males of this species lack lobes on the aedeagus (Fig. 390), and the adult head pattern resembles that of *I. ouachita* (Fig. 424). Nymphs have longitudinal bands with narrow pale borders (Fig. 441). This species was originally reported from the Gulf Coastal Plain of Texas (Szczytko and Stewart 1977), and based on our preliminary collections, was reported in Arkansas and Oklahoma (Stark et al. 1986). In this study, it was restricted to Gulf Coastal Plain streams, and Crowley's Ridge. It appeared to prefer clean streams with sand or fine gravel substrates. Emergence occurs from mid-March through April.

Isoperla decepta Frison
Figs. 388, 403, 412, 423, 436, 437, 446, 458

Isoperla decepta Frison (1935).

Type locality.— Illinois, New Columbia.

Regional distribution.— Watersheds 87-89, 94, 101, 106-109, 111, 126 (Table 1).

Discussion.—The male aedeagus has a patch-like indentation with a fleshy lobe bearing a sclerotized tooth-like spine (Fig. 388), and female sternum 8 overlaps less than 1/4 of sternum 9 (Fig 411). The small yellow adults have light grey wings and the head has no dark pigmentation. Nymphs have a pair of spots on each abdominal sterna (Fig. 436). Frison (1935) collected this species in southern Illinois, but it was not previously reported west of the Mississippi River. In this study, it was found commonly in the Missouri and Mississippi River border subregions (Table 2), and apparently is able to tolerate a considerable amount of organic enrichment. Emergence occurs from mid-April to mid-May.

Isoperla dicala Frison

Figs. 387, 406, 410, 420, 439, 449, 450

Isoperla dicala Frison (1942).

Type locality.— Michigan, Free Soil.

Regional distribution.— Watersheds 25, 38, 47, 68, 93, 95, 100, 109, 124 (Table 1).

Discussion.—The adult head pattern of this species is light- colored with brown pigment connecting ocelli (Fig. 420). The aedeagus has a single, ventral tooth basally (Fig. 387), and nymphs are generally dark olive-green or brown with pigment connecting lateral ocelli and the posterior margin of the head (Fig. 439). Stark et al. (1986) noted its ocurrence in Missouri, and a widespread distribution in northern and eastern North America. Regionally, it was entirely restricted to springs and streams which remained cool throughout the summer. Withrow Springs near Huntsville, Arkansas, and the lower Eleven Point River are the southernmost localities within the region. Emergence is later than other regional *Isoperla*, beginning in late April and continuing through early June.

Isoperla mohri Frison

Figs. 391, 399, 414, 422, 429, 445, 455

Isoperla mohri Frison (1935).

Type locality.— Illinois, Little Salt des Flusses, Watson.

Regional distribution.— Watersheds 1, 2, 5-7, 11, 19, 25, 29, 35, 37, 38, 40, 49, 50, 52-54, 56, 57, 59, 60, 62, 67, 70, 72, 73, 75, 76, 78, 80, 82, 86-88, 90, 98, 101, 107-109, 115-120, 126 (Table 1).

Discussion.— Males of this species are distinguished by the 2 rows of numerous, long teeth within a patch-like indentation on the male aedeagus (Fig. 391). Nymphs have a single lacinial tooth (Fig. 455). Frison (1935) reported it from the Illinois Ozarks, Stark and Stewart (1973a) reported it from Oklahoma, and Feminella and Stewart (1986) studied an Arkansas population that shifted food habits from omnivory to carnivory during nymphal growth. Like *I. ouachita*, this species occurs in intermittent streams and those that dry up in summer. Emergence occurs from late March through April.

Isoperla namata Frison

Figs. 394, 405, 416, 418, 432, 433, 447, 454

Isoperla namata Frison (1942).

Type locality.— Missouri, Wayne County, Silva.

Regional distribution.— Watersheds: 2-4, 8, 13, 14, 17, 22, 23, 25, 26, 28, 32, 35, 36, 38, 41-50, 52, 53, 56, 57, 60, 61, 65, 66, 68, 71, 72, 74, 81, 83-87, 90-93, 96-100, 102-104, 107, 109-111, 115-125 (Table 1).

Discussion.— Adults of this species cannot be reliably separated from *I. signata*, but our key reflects subtle characters that distinguish most regional populations. Like *I. bilineata*, nymphs usually do not have continuous dark pigmentation from the ocelli to the posterior margin of the head (Figs. 432, 433). It was reported from Missouri by Frison (1942), and more recently from Oklahoma (Ernst and Stewart 1985b) and Arkansas (Feminella and Stewart 1986). It was absent from lowland subregions (Table 2). A slow- growing, late-emerging population was discovered at Alley Spring, Missouri, which had a yearly water temperature range of 13-16°C, suggesting this species may not require temperature fluctuation for egg incubation and growth. The nymphal head pattern of this population differed from those collected at other localities (Fig. 433). It was collected most frequently from permanent streams and emerges from mid-April through May.

Isoperla ouachita Stark and Stewart

Figs. 389, 404, 413, 424, 430, 440, 453

Isoperla ouachita Stark and Stewart (1973b).

Type locality.— Oklahoma, Latimer County, Pine Creek.

Regional distribution.— Watersheds 1-5, 6-10, 13, 14, 16-23, 25-29, 31-50, 52-57, 60, 61, 64-69, 71-81, 83-87, 89-93, 95-100, 102-104, 107-111, 113, 115-118, 120-125 (Table 1).

Discussion.—The male aedeagus has several lobes, but no sclerotized teeth (Fig. 388). The adult head is dark along most of the anterior margin. Nymphs have broad lacinia, bearing a single tooth and an even row of spines (Fig. 453). This was the most common, widespread

Isoperla in the Ozark- Ouachita Mountains, and is endemic to the region. However, it was not collected in the Illinois Ozarks or Crowley's Ridge. It was abundant in intermittent streams and those that are dry during summer, which suggests an egg diapause in its life history. Emergence occurs from mid- March to the end of May.

Isoperla signata (Banks)
Figs. 396, 402, 408, 419, 434, 442, 451

Perlinella signata Banks (1902).
Isoperla signata: Claassen (1940).
Walshiola signata: Banks (1948).
Isoperla signata: Harden and Mickel (1952).

Type locality.— Michigan.

Regional distribution.— Watersheds 4, 36, 66, 81, 91, 96, 99, 102, 103, 110, 124, 125 (Table 1).

Discussion.— Nymphs of this species are often confused with *Isoperla marlynia* Needham and Claassen. It is not certain whether nymphs pictured by Frison as *Isoperla clio* (1935, 1942) were of *I. marlynia* or *I. signata*. Stark and Stewart (1973a) reported *I. marlynia* from four Oklahoma localities, and Brown and Ricker (1982) reported it from Arkansas, but due to the similarity of this species with *I. signata*, it is probable that these two species were confused. Our large series of nymphs and reared adults from these same localities were *I. signata*, and Ernst and Stewart (1985b) recently reported this species from northeastern Oklahoma. It is more common in cooler, northern climates, and regional localities are disjunct from them. In this study, it was restricted to permanent streams, containing flow from springs. It was most frequently collected in the Springfield and Curtois subregions where springs are common (Table 2). Emergence is from mid-April through mid-May.

Isoperla szczytkoi Poulton and Stewart
Figs. 25, 395, 401, 407, 425, 435, 444, 456

Isoperla szczytkoi Poulton and Stewart (1987).

Type locality.— Arkansas, Logan County, Gutter Rock Creek.

Regional distribution.— AR: Logan Co., Gutter Rock Cr., 4.4 km S Corley, 21-III-84, 4n, BCP, also 20-IV-85, reared 6 M, 3 F, 6n, BCP.

Discussion.— This species has an indented triangular patch bearing 7-8 teeth on the male aedeagus (Fig. 395), and the nymph has diagonal tergal bands (Fig. 444). It was only collected from the upper reaches of Gutter Rock Cr. on Magazine Mountain, the highest elevation in the region (853 m msl). This locality is a hyporheal stream with steep gradient and large rock rubble, but becomes organically enriched further downstream. This species was absent from nearby streams and is probably isolated. Nymphs were reared in April, and emergence probably continues through early May.

Helopicus nalatus (Frison)
Figs. 367, 372, 374, 378, 381

Hydroperla nalata Frison (1942)
Isogenus (Helopicus) nalatus: Ricker (1952)
Helopicus nalatus: Illies (1966)

Type locality.— Michigan, Huron River.

Regional distribution.— Watersheds 3, 4, 8, 17, 22, 32, 35, 36, 55-57, 81, 83, 84, 86, 89, 91, 96, 97, 102-104, 110, 115, 117-119, 122, 123 (Table 1).

Discussion.— This species is distinguished from *H. crosbyi* by the absence of lateral stylets on the male epiproct (Fig. 372), and a female subgenital plate that covers 1/2 or more of sternum 9 (Fig. 374). Nymphs are distinguished by the dark, straight pigment band across the head (Fig. 378). Stark and Stewart (1973a), Feminella and Stewart (1986), and Stark and Ray (1983) reported it from several regional localities. It was misidentified as *Isogenoides varians* (Walsh) during a Missouri study (Jones et al. 1981). These specimens, available through a loan from the University of Missouri collection, were confirmed as *H. nalatus*. The Michigan and Indiana populations are separated from regional distributions. This species was restricted to permanent streams in mountainous subregions, and was rarely collected in large numbers. The nymphs appeared to prefer large boulders and fast currents, and adults were secretive. Emergence was from late February through March.

Hydroperla crosbyi (Needham and Claassen)
Figs. 27, 368, 371, 375, 379, 382

Perla crosbyi Needham and Claassen (1925).
Hydoperla crosbyi: Frison (1935).

Type locality.— Missouri.

Regional distribution.— Watersheds 1, 5, 7-11, 13, 14, 18, 19, 21, 22, 25, 27, 33-37, 39, 42-45, 48, 52, 53, 56, 57, 60, 61, 64, 65, 69, 71, 73, 74, 76, 77, 80, 82, 86, 88-91, 97, 101, 104, 107-109, 111-119, 125 (Table 1).

Discussion.— This common species can be distinguished from *Helopicus nalatus* by the lateral stylets on the male epiproct (Fig. 371), and the rounded female subgenital plate produced over 1/3 - 1/4 of sternum 9 (Fig. 375). The nymph has a sinuate band across the head (Fig. 379). Illies (1966), and Ray and Stark (1981) reported it from all states within the region, where it was more common than *H. nalatus*. Nymphs are known to inhabit leaf packs and organic debris (Stewart and Huggins 1977), and often occupied lowland streams similar to those containing *Clioperla clio*. Oberndorfer and Stewart (1977) reported that *H. crosbyi* was able to survive in intermittent and dry streams in Texas due to their dessicant-resistant diapausing eggs. It was also found in permanent, large rivers with high levels of organic debris. Emergence occurs from late February through early April.

Hydoperla fugitans (Needham and Claassen)
Figs. 376, 377, 380, 383

Perla fugitans Needham and Claassen (1925).
Hydroperla harti: Frison (1935).
Isogenus (*Hydroperla*) fugitans: Ricker (1952).
Hydroperla fugitans: Illies (1966).

Type locality.— Texas, Austin.

Regional distribution.— IL: Randolph Co., Kaskaskia R., Shelbyville, 10-IV-32, T.H. Frison. MO: Scott Co., unknown locality, 31-III-38, 1M, 2F, W. F. Turner.

Discussion.— This species can be distinguished from *H. crosbyi* by the shape of the male epiproct (Fig. 377) and the triangular female subgenital plate (Fig. 376). Nymphs lack the anterior head band which is present in *H. crosbyi* (Fig. 380). Frison (1935) and Ray and Stark (1981) indicated it was a large river species. Although Ricker (1952) listed this species in Arkansas, and others have reported it in surrounding states (Kansas, Stewart and Huggins 1977; Texas, Szczytko and Stewart 1977), it is considered rare. No recent publications have provided locality records, and no specimens were collected during this study. Emergence is reported in March and April.

Family Pteronarcyidae

Jones et al. (1981) reported two pteronarcyid species from Missouri streams. The University of Missouri collection contained nymphs from many localities, but the species identity was unknown. Based on these collections, and reared material from this study, *Pteronarcys pictetii* is the common regional species in this family. It is the largest regional stonefly, and some adults were 5-6 cm in length. Nymphs are brown or black, and have gills on the thorax and abdominal segments 1 & 2 (Fig. 462). No adults were collected in this study, but in Wisconsin streams, they are found in riparian vegetation, and beneath bridges. Nymphs are herbivorous, and can be collected in large streams from snags and organic debris. During this study, high water levels often prevented collections of nymphs. Hitchcock (1974) provided a key to separate eastern species, but nymphs of *P. pictetii* are not reliably separable from those of *P. dorsata* (Say).

Key to Genera and Species of Pteronarcyidae

Males and Females

1. Tip of sternum 9 curved ventrad (Fig. 464); female subgenital plate with square notch (Fig. 461) .... ***P. pictetii*** Hagen
   Tip of sternum 9 not curved ventrad (Fig. 463); female subgenital plate unnotched, with 2 small projections (Fig. 460)...................... ***P. dorsata*** (Say)

Pteronarcys pictetii Hagen
Figs. 21, 26, 461, 462, 464

Pteronarcys pictetii Hagen (1873).

Type locality.— Pennsylvania, Philadelphia.

Regional distribution.— Watersheds 24, 26, 38, 41, 47, 53, 55, 67-69, 85-87, 93, 95-97, 99, 100, 104, 108, 109, 116, 120, 122-125 (Table 1).

Discussion.— Nymphs were collected from several large river systems, and 76 adults were reared from 15 localities. *Pteronarcys dorsata* (Say) is included in the key to provide comparisons (Figs. 460, 463), in case this species is discovered during future studies. Nymphs in their last instar were collected in January from leaf packs and debris, and emerged in the laboratory 1-2 months earlier than their normal emergence period, following daily increases in Living Stream temperatures of about 1-2°C/day. This species was restricted to large rivers, which usually recieved spring water or cold tailwaters below reservoirs. The largest numbers were collected from the upper Current and Jacks Fork Rivers in Missouri. Watersheds listed above include the first Arkansas localities, and probably represent the southwestern limit of its range. Judging from collections of medium-sized nymphs in May, it is presumably one of the few semivoltine species in the region. Emergence was in April, which was one month earlier than for northern populations.

DISCUSSION

Stonefly distributions in eastern North America are not well documented, except for the studies of Ricker (1964), Ross et al. (1967), Ross and Yamamoto (1967), and the recent state lists of Louisiana (Stewart et al. 1976), Mississippi (Stark 1979), Florida (Stark and Gaufin 1979), Alabama (Stark and Harris 1986), Virginia (Kondratieff and Kirchner 1987), North and South Carolina (Unzicker and McCaskill 1982), West Virginia (Tarter and Kirchner 1980), Kentucky (Tarter et al. 1984), and Indiana (Bednarik and McCafferty 1977). There has been no concerted effort to sample the stonefly fauna of entire natural regions such as the Appalachian Mountains or associated ranges in relation to physiographic or biotic characteristics, and specifically no study has been done on the Ozark-Ouachita Mountain region. Fishes (Pflieger 1971; Hocutt and Wiley 1986; Mayden 1985; Robison and Buchanan 1988) and mayflies (Ephemeroptera)(McCafferty and Provonsha 1978) are the only aquatic groups that have recieved attention in the region. Plecoptera distributions can provide clues to past dispersals in eastern North America (Ross and Ricker 1971), and distributional patterns for the 88 known species in the Ozark-Ouachita region can be attributed to their ecological requirements, topography, climate and geological/glacial history.

There is considerable evidence that eastern North America once contained clear streams with a more uniform gradient and cooler temperature regimes than at present (Thornbury 1965). In the Illinois Ozarks, evidence of past boreal habitat belts exist (Udvardy 1969). The Interior Highlands, encompassing the area between the Mississippi River and the Great Plains, which includes the Ozark- Ouachita region, underwent changes in stream characteristics as the "Ozark Dome" was alternatively uplifted and degraded during the Pliocene (Bretz 1965). These changes included increased gradient and erosion, breaching of the water table and subsequent formation of springs (Ross 1963, 1965).

It is generally thought that the Pleistocene glaciations lasted about 1 million years, and included four major glacial advances, separated by warmer interglacial periods of about 10,000 years when glaciers retreated northward (Udvardy 1969). The Kansian extended the furthest south (Fig. 1), and the Wisconsin was the most recent, retreating about 10,000 years ago. Since the glacial front reached only as far south as the Missouri River (Fig. 1), major changes in stream drainages probably did not occur in the Interior Highlands during glacial periods (Pflieger 1971), although climate and subsequent stream temperatures probably differed enough to affect the distribution and dispersal of species at that time (Ross and Ricker 1971). Stonefly species that moved south ahead of glacial advances were left behind after glacial retreats, and now presently occupy "refugia", or isolated habitats with preserved environmental conditions that were more continuous before and during glaciation (Udvardy 1969). This pattern is manifested today by the presence of biogeographic "relicts", or species restricted to these refugia, often resulting in discontinuous distributions.

The distribution patterns of Ozark-Ouachita Plecoptera generally fall into three different categories: 1) endemic species, either products of speciation within the region or sister species to those in the Appalachian Mountains, 2) those with continuous distributions, or those that are widespread with presently open dispersal pathways via the Illinois Ozark corridor (Ricker and Ross 1971), and 3) those with discontinuous distributions, or that are geographically separated from more northern or eastern populations, where they may be more common.

There are a total of 25 endemic species of Plecoptera known from the Ozark-Ouachita region. In comparison, Hocutt and Wiley (1986) reported 27 endemic species of fishes from the Interior Highlands. Robison and Harris (1978) noted the possibility of previous connections between the Caddo, Little Missouri and Ouachita River systems based on the endemic fish species common to their headwaters. Mayden (1985) also provided distributions of endemic headwater fish species as evidence of previous stream drainage connections between the Ouachita and Little Missouri Rivers. Records of endemic stonefly species within the drainages of these systems seem to parallel those of some fishes, particularily *Alloperla ouachita*, which was found only in the headwaters of these drainages (Fig. 469). Although not based on geological evidence, the distributions of *Alloperla caddo* (Fig. 469) and *Zealeuctra wachita* (Fig. 466) similarily suggest that connections may have previously existed between the Ouachita, Saline, and Fourche la Fave watersheds. Another plausable explanation for the distribution of endemics from headwater systems is that of multiple headwater transfer (Pflieger 1971; Matthews and Robison 1988), which is certainly more of a present-day dispersal possibility for stoneflies than for fishes.

Several endemic *Allocapnia*, including *A. mohri* and *A. ozarkana*, are considered sister species to members of the Appalachian fauna (Ricker and Ross 1971). *Allocapnia sandersoni*, *A. peltoides*, and *A. warreni* are endemics that may represent possible products of sympatric speciation, since presumed sister species *A. rickeri* and *A. granulata*, respectively, are also found within the region.

Presently, there are 26 regional species which have continuous distributions due to their abundance throughout the Interior and Northern Highlands, and east of the Mississippi River. *Clioperla clio*, *Hydroperla crosbyi*, *Perlesta decipiens*, *Allocapnia granulata*, *Allocapnia rickeri*, *Haploperla brevis* and *Zealeuctra claasseni* presumably dispersed northward after the last glacial retreat, and presently occupy previously glaciated terrain. Others such as *Allocapnia forbesi* and *Zealeuctra fraxina* reached the Illinois Ozarks but did not cross the Mississippi River. Species such as *Allocapnia mystica* probably dispersed northward during glacial retreat, but required stream habitats with suitable gradients, which caused a distributional bottleneck at the Illinois Ozarks.

Discontinuous distributions due to the presence of small refugia with suitable conditions are perhaps the most noteworthy, and can be ecologically or historically based. Some widespread regional species are separated from eastern or northern populations by "cultural deserts" that act as dispersal barriers where survival is unlikely, such as the Mississippi Alluvial Plain with its low gradient, channelized streams and heavily cultivated topography. Other species are limited to a few isolated refugia that have preserved ecological characteristics allowing their survival in the region, but are more widespread and common in northern or eastern climates, and are unable to disperse because of the limited frequency of these habitats. *Isoperla burksi* and *I. signata* have widespread distributions in the Ouachitas and Ozarks, respectively, but are separated from populations further north and east of the Mississippi River. *Alloperla hamata*, *Neoperla carlsoni*, and *Taeniopteryx lonicera* (Figs. 467-469) are represented by relict populations, and do not occur in previously glaciated areas. These species probably had continuous distributions when a sounthern disperal route between the Appalachians and Ozarks was present before the Mississippi River occuped its present stream channel (Udvardy 1969). Similarly, *Shipsa rotunda*, *Prostoia similis*, and *Nemocapnia carolina*, which do occur in previously glaciated areas are also found in isolated refugia which have similar characteristics to streams in northern and northeastern North America (Figs. 465, 467).

Spring streams with cooler summer water temperatures provide fine examples of refugia that contain restricted populations of stonefly species that are more common in northern latitudes. Some cold water fishes are also known from these systems (Pflieger 1975; Robison and Buchanan 1988). *Isoperla dicala*, *Agnetina capitata*, *Paragnetina media*, *Allocapnia pygmaea*, and *Pteronarcys pictetii* probably dispersed south ahead of glacial advances, then dispersed northward again during glacial retreats, leaving behind populations only in streams with suitable temperature regimes.

The Ozark - Ouachita region is the most arid mountainous region in eastern North America (Rafferty 1985). In addition to a relatively warm climate, the region lacks significant altitude to provide cool temperatures in most streams during summer months (Fig. 3). Interestingly, streams containing significant spring flow maintained warmer winter temperatures and lacked many winter genera common to most regional streams with near - freezing temperatures during winter. Although apparently excellent habitats existed, *Taeniopteryx*, *Strophopteryx*, and *Allocapnia* (except for the previously mentioned *A. pygmaea*) species were rare or absent from spring streams. In this respect, regional streams with greater yearly temperature fluctuation generally had greater stonefly diversity than spring streams, possibly due to lack of a low end thermal cue required for egg hatching of some winter species. Conversely, temperatures as high as 31°C were recorded during summer months from permanent streams without spring flow, which may be too high to properly cue eggs and young nymphs of species with immediate hatching such as *P. media* (Heiman and Knight 1970), or species with nymphal diapause such as *A. pygmaea* (Pugsley and Hynes 1985). In these respects, the thermal regime of Ozark - Ouachita streams is unique and may be unsuitable for the Peltoperlidae, the only North American stonefly family that does not occur in the region.

From the computerized cluster analysis, four clusters were chosen based on equal cluster distances and gaps in the dendrogram that provided the most biologically meaningful divisions (Fig. 5, Table 2). As mentioned previously, watersheds were clustered based on similarity of their stonefly fauna. Cluster 1 included watersheds located primarily in lowland areas surrounding the interior Ozark- Ouachita subregions, which have low gradient streams with finer substrates, including the Gulf Coastal Plain, Missouri River Border, and Illinois Ozarks. Species typical of streams in this cluster include *Acroneuria abnormis*, *Allocapnia malverna*, *Amphinemura nigritta*, *Isoperla bilineata*, *I. coushatta*, and *I. decepta*. A few scattered watersheds (20, 31, 92, 98) clustered with them because of low numbers of collection records. Cluster 2 included watersheds within the Ouachita, Arkansas River Valley, and parts of the Boston Mountain subregions (Fig. 5). This cluster contains the highest number of regional endemics (Table 3), and consists of geologically similar watersheds (Mayden 1985). Species typical of this cluster include *Alloperla caddo*, *Allocapnia ozarkana*, *A. peltoides*, *Perlesta baumanni*, and *Zealeuctra cherokee*. Cluster 3 included most of the watersheds in the White River, Central Plateau, Osage-Gasconade Hills, Mississippi River Border, and the St. Francois Mountains (Fig. 5). These watersheds generally contain low numbers of endemic species, but include a variety of stream types. Species unique to this cluster include *Acroneuria ozarkensis*, *Alloperla hamata*, *A. leonarda* and *A. ouachita*. Cluster 4 included geologically similar watersheds fed by large springs in south central Missouri and northern Arkansas (Fig. 5). Typical species found under these conditions include *Agnetina capitata*, *Isoperla dicala*, *Leuctra tenuis*, *Paragnetina media*, *Pteronarcys pictetii*, and *Perlesta_shubuta*. Watersheds 14, 39, and 61 clustered with them, presumably due to small headwater springs or their physiographic position as ecotones, and included *Acroneuria internata* and *Paragnetina kansensis*.

Cluster results (Fig. 5) did not match subregional divisions (Fig. 2) that were based on geology, soil type, and vegetation, but were similar to some Arkansas fish faunal regions calculated with defined drainage units and principal components by Mathews and Robison (1988). Their five region solution contained more detailed subdivision of Gulf Coastal Plain streams based on large river fishes (Mathews and Robison 1988). In this study, a seven cluster solution (not shown) separated cluster 1 into the Gulf Coastal and Mississippi Alluvial Plains, but based on stream characteristics, other divisions in this solution did not appear reasonable.

In summary, the combination of mountainous topography, high gradient streams, varying flow permanence and temperature regimes, and warm climate make the Ozark- Ouachita Mountains and its diverse Plecoptera fauna unique among the natural physiographic regions of North America. Faunistically based clusters of watersheds elucidated in this study (Fig. 5) were similar to those based on species of fishes in other studies (Matthews and Robison 1988). Even though some species had strong affinities for a particular subregion (Table 2), the presence/absence of many uncommon species reflected historical (often glacial) distributions and geographic or ecological isolation. This appears to suggest that more specific characteristics were responsible for the presence/absence of many regional stonefly species. A total of 23 species were common in intermittent or dry streams, which probably have heterodynamic life cycle capabilities such as diapausing eggs (Stewart and Stark 1988). In addition, 28 species were restricted to either permanently flowing streams or those with significant spring water that altered the thermal regime. Based on this study, the best predictors of stonefly presence/absence within the region were stream thermal regime and flow permanence due to their apparent relationship to certain stonefly life cycle requirements.

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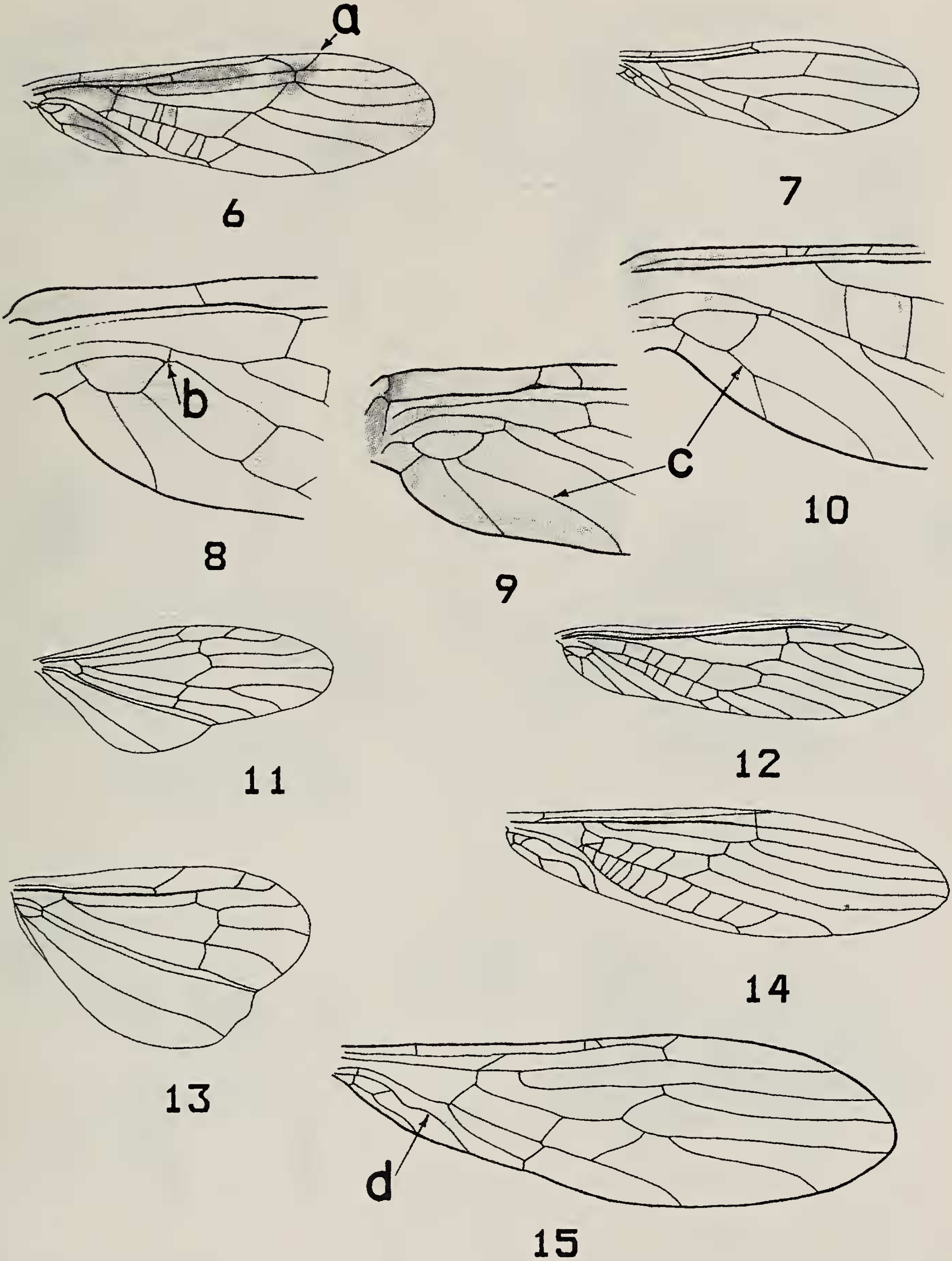

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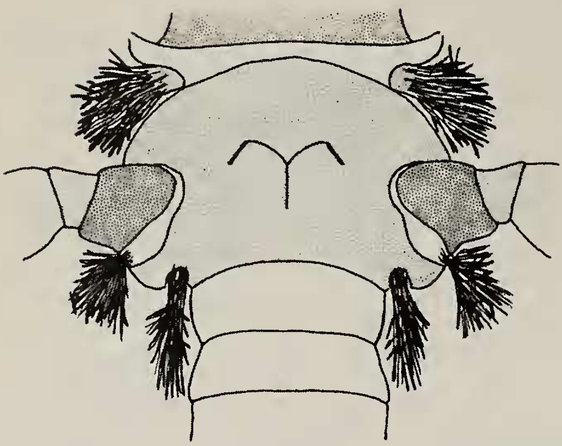

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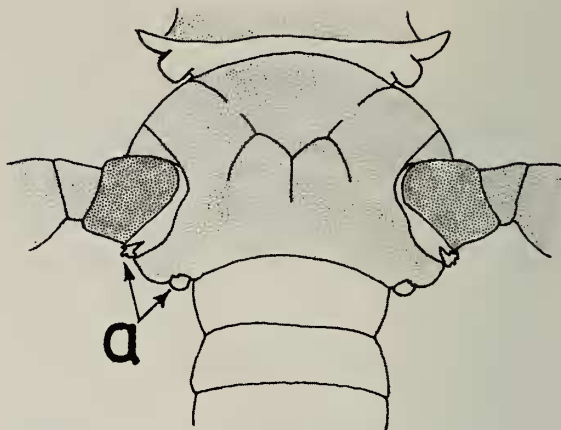

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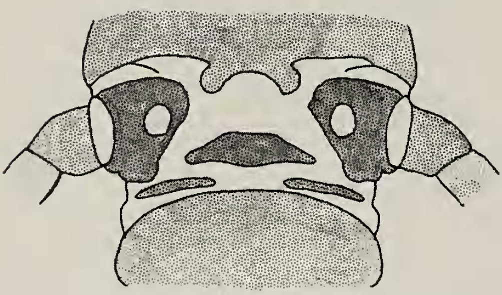

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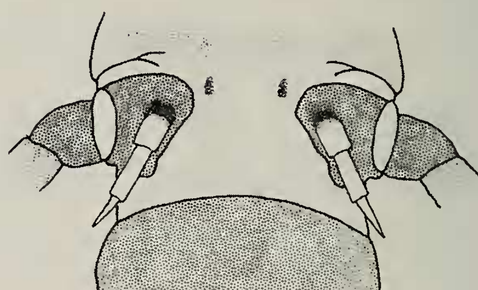

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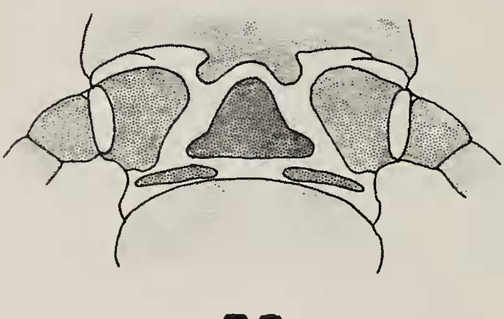

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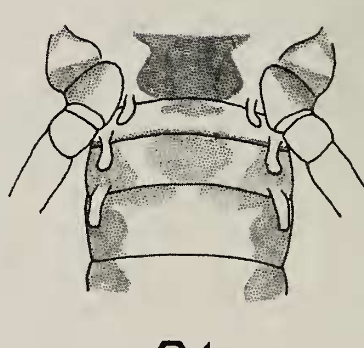

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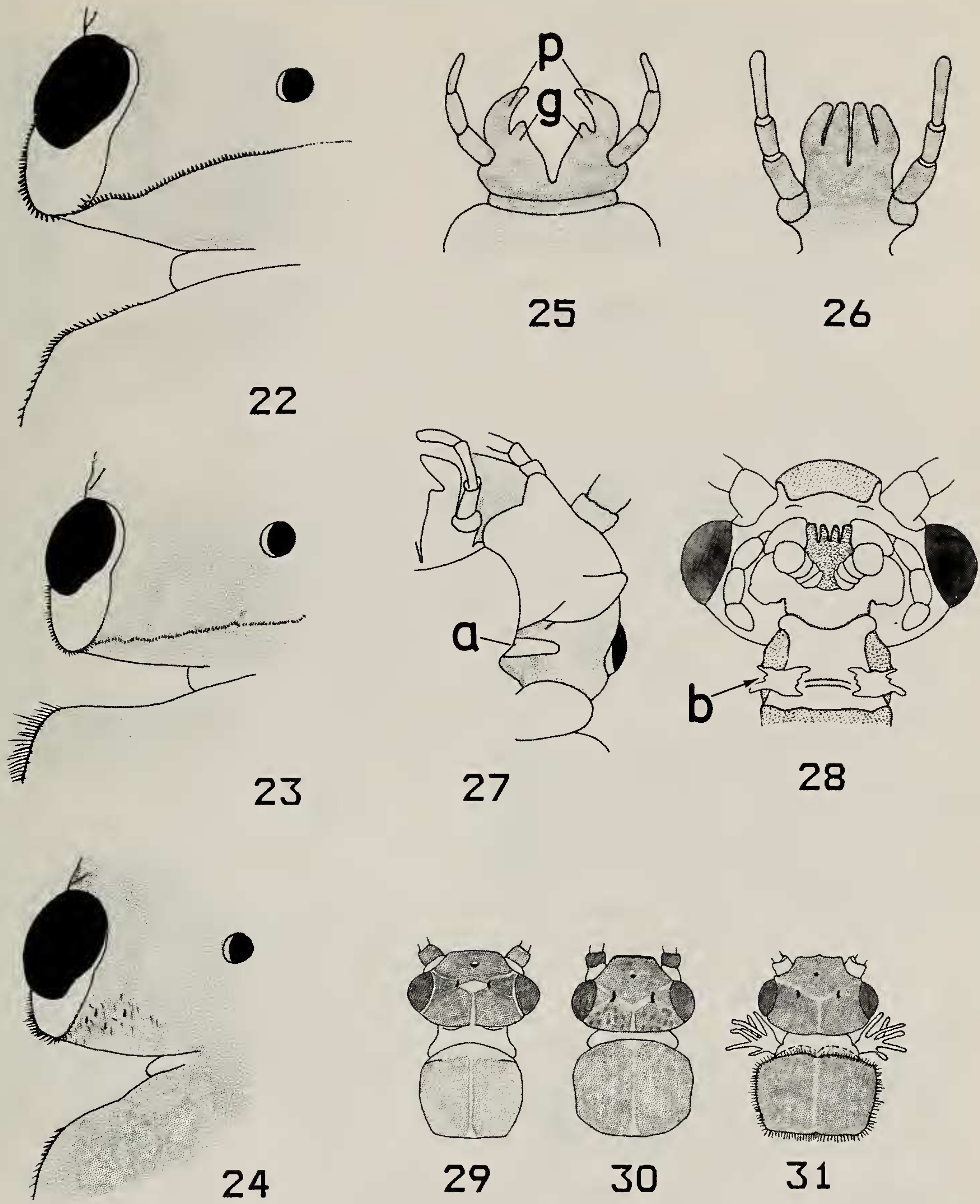

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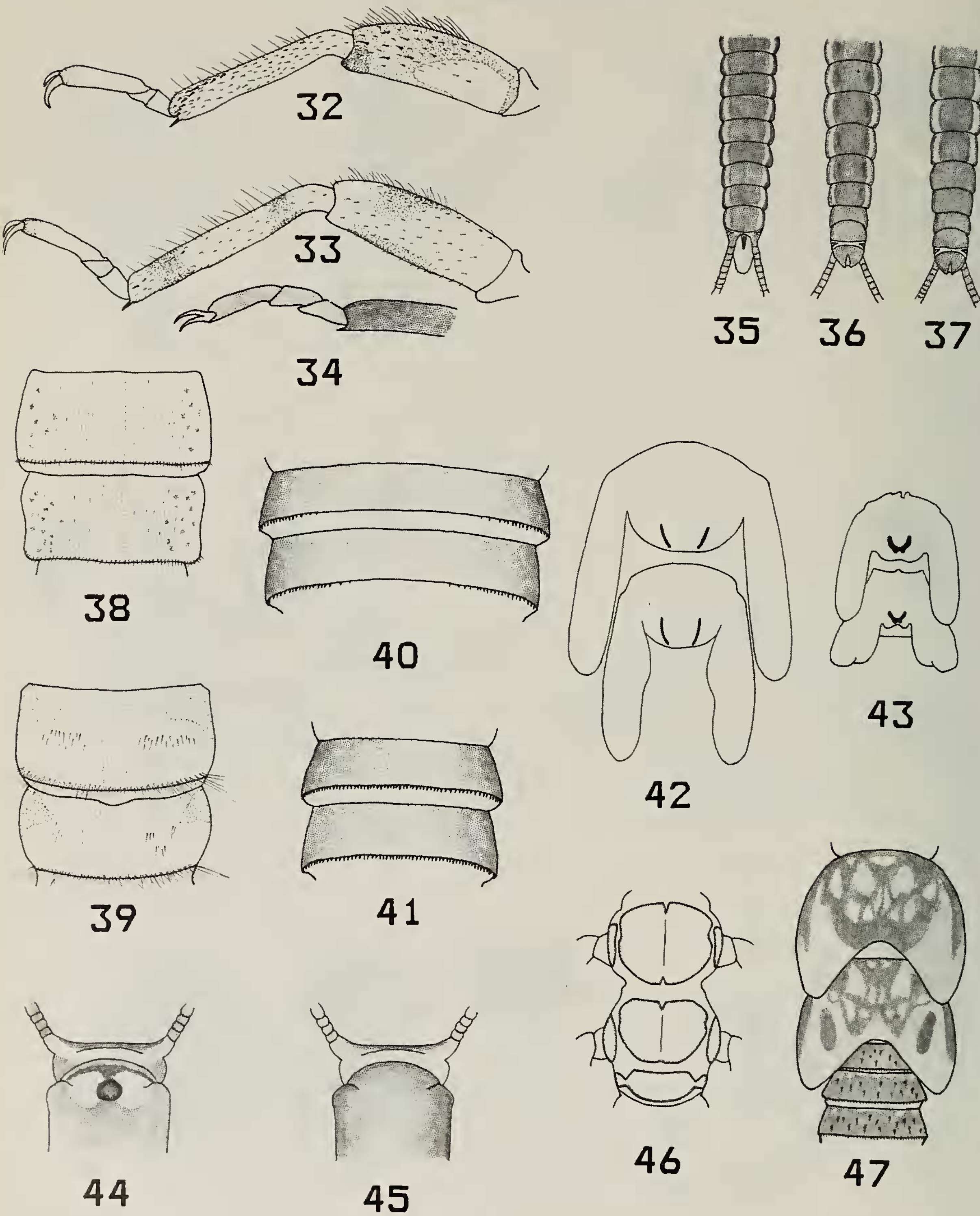

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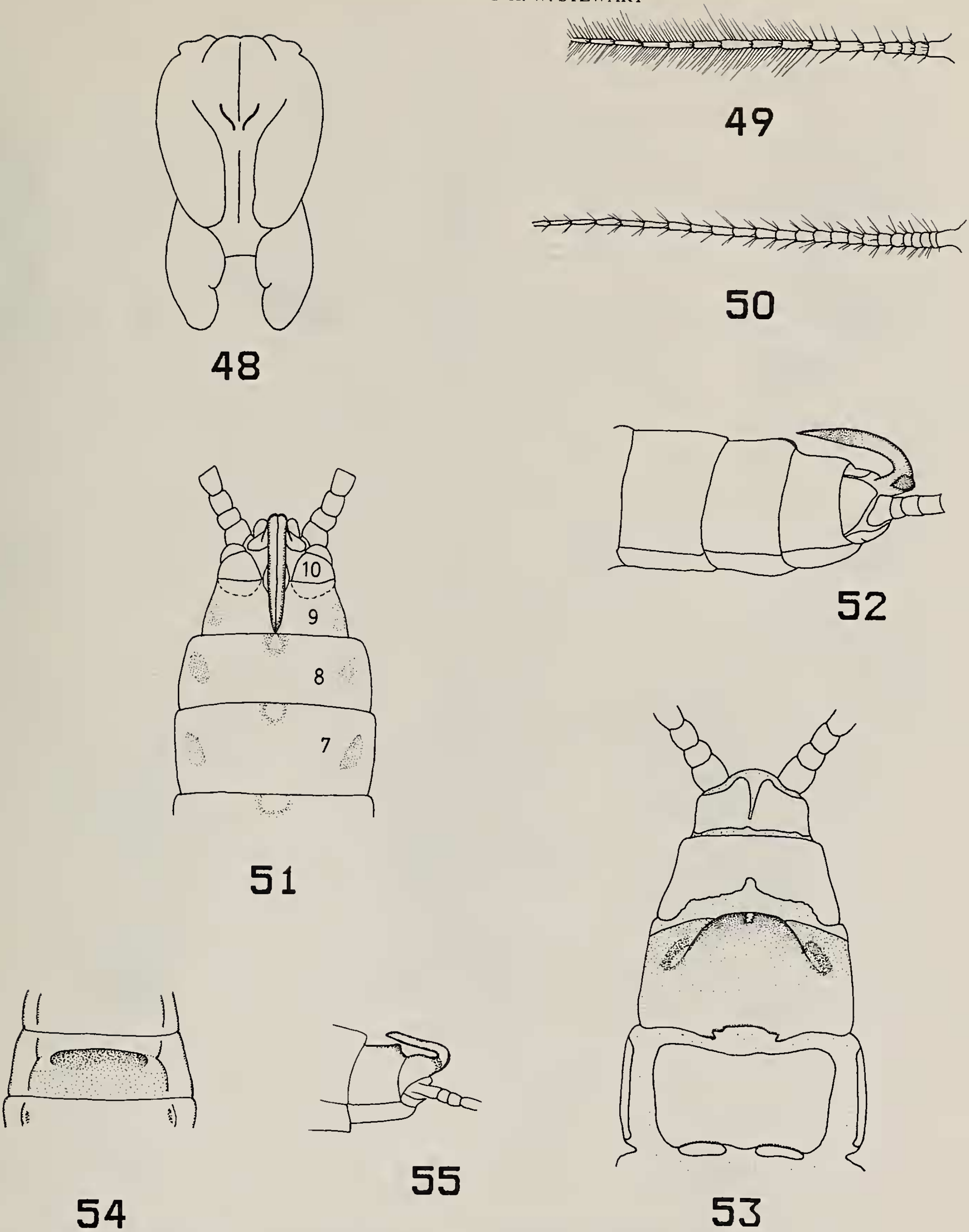

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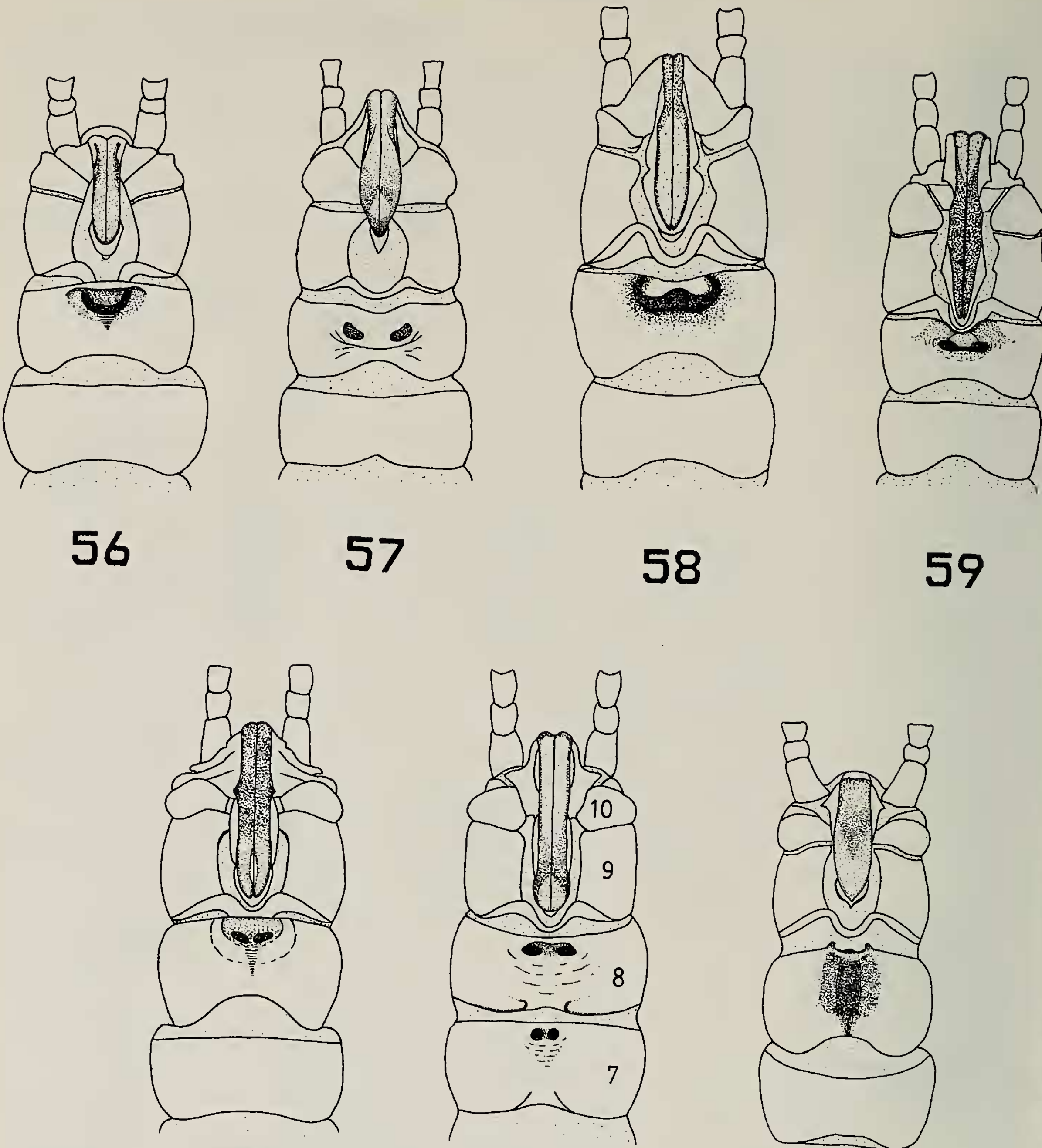

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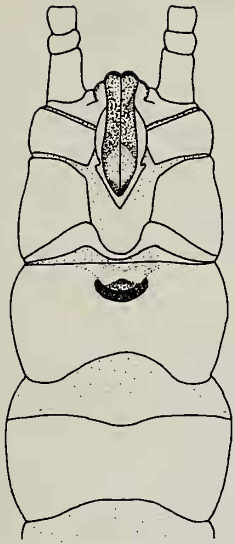

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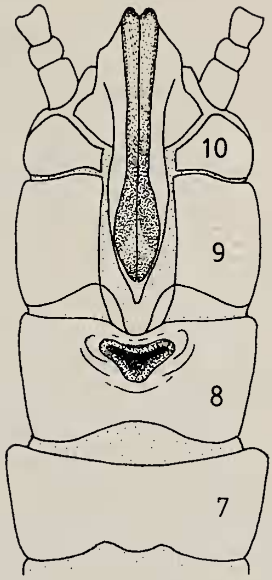

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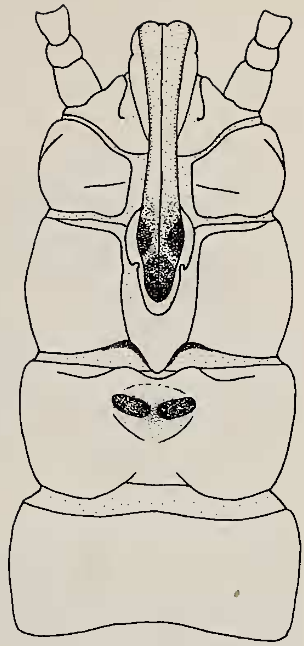

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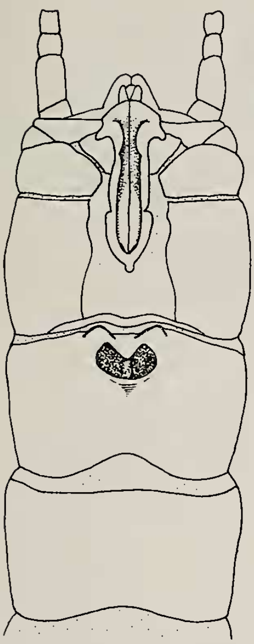

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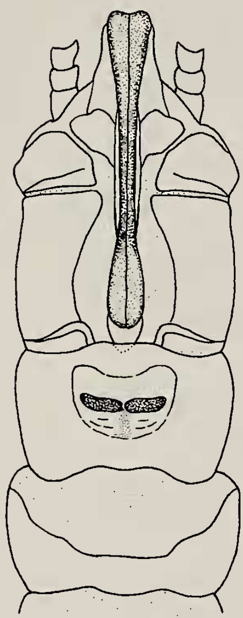

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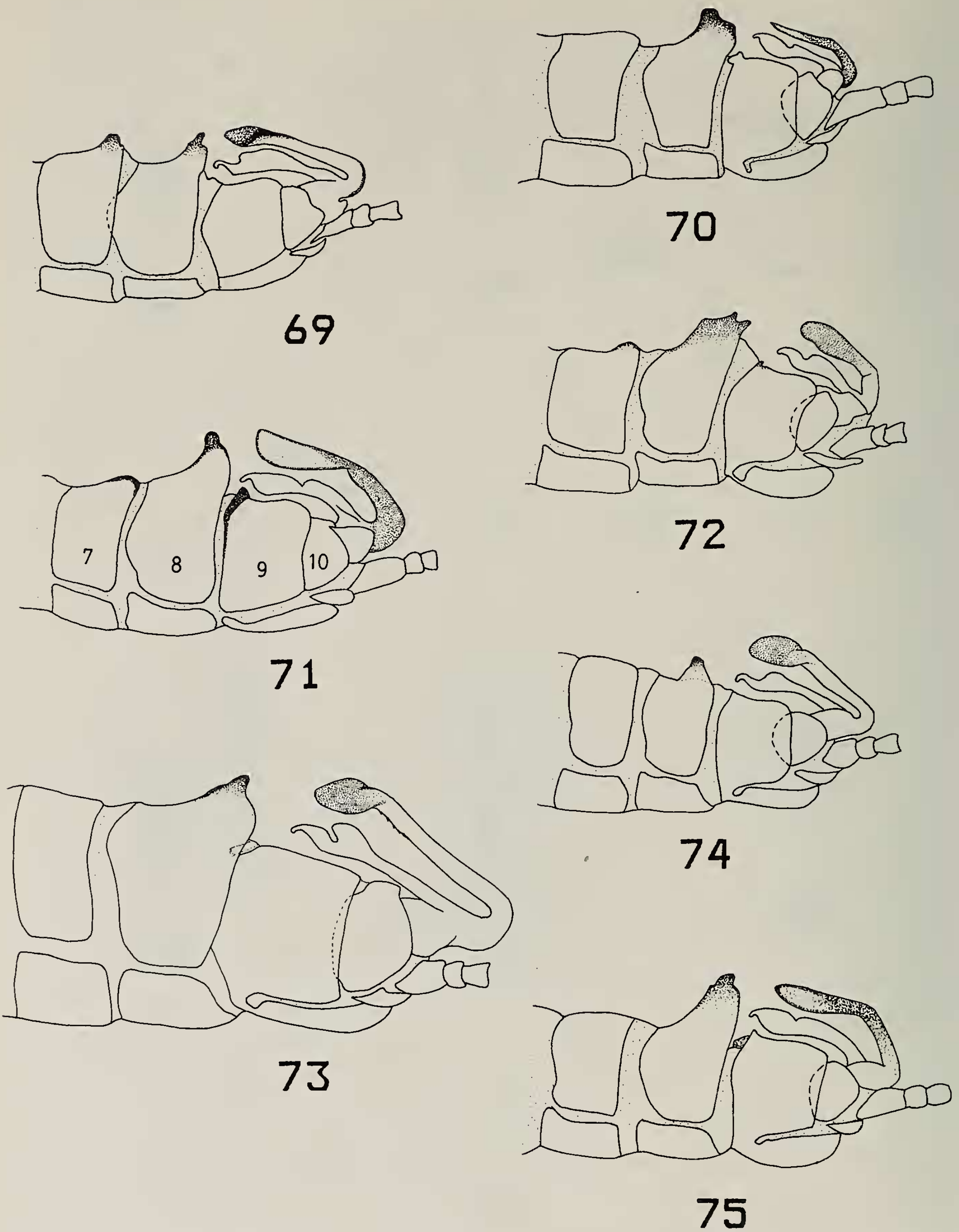

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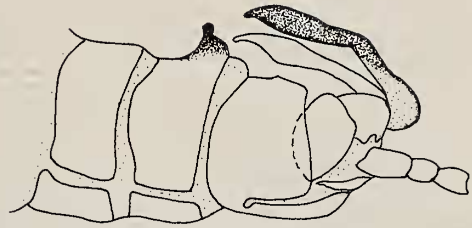

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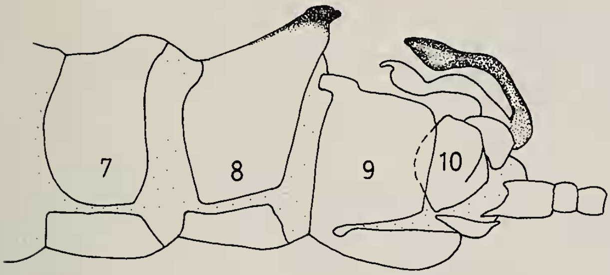

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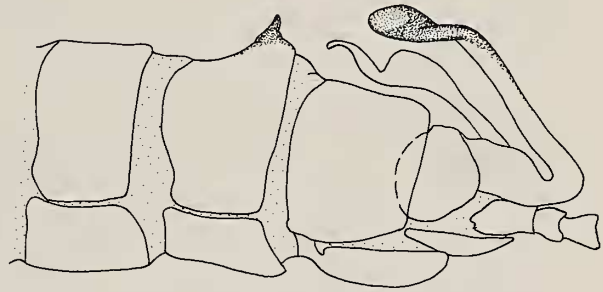

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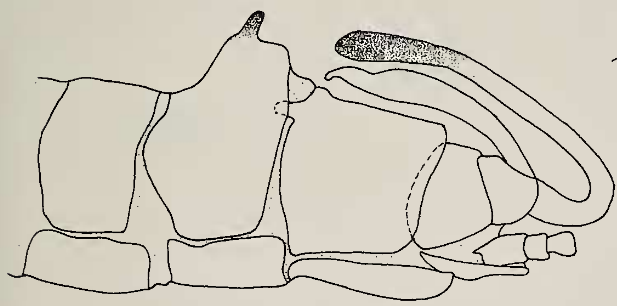

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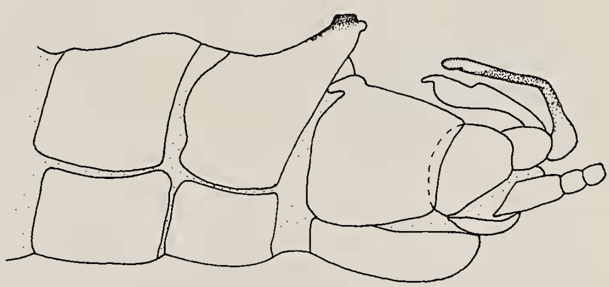

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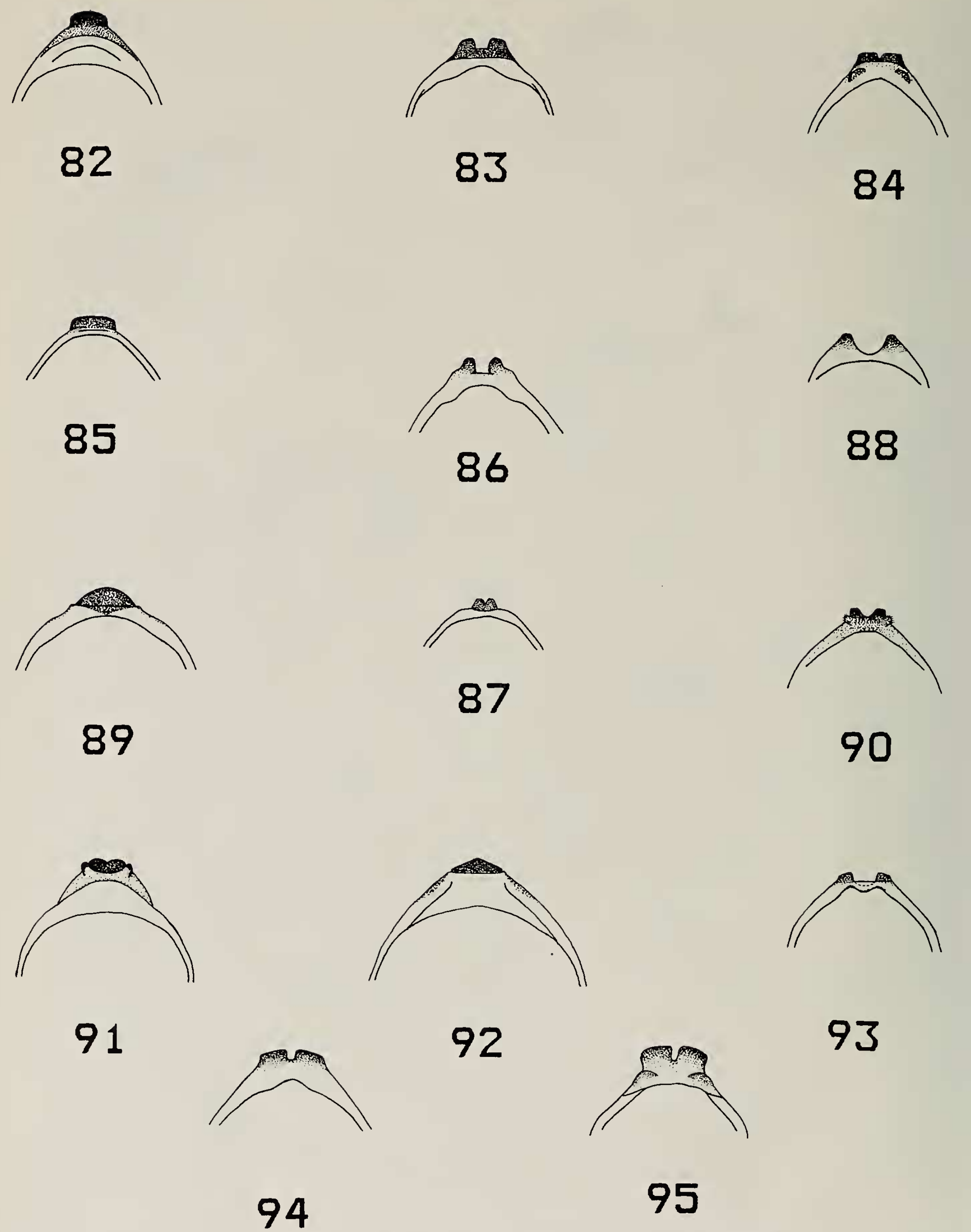

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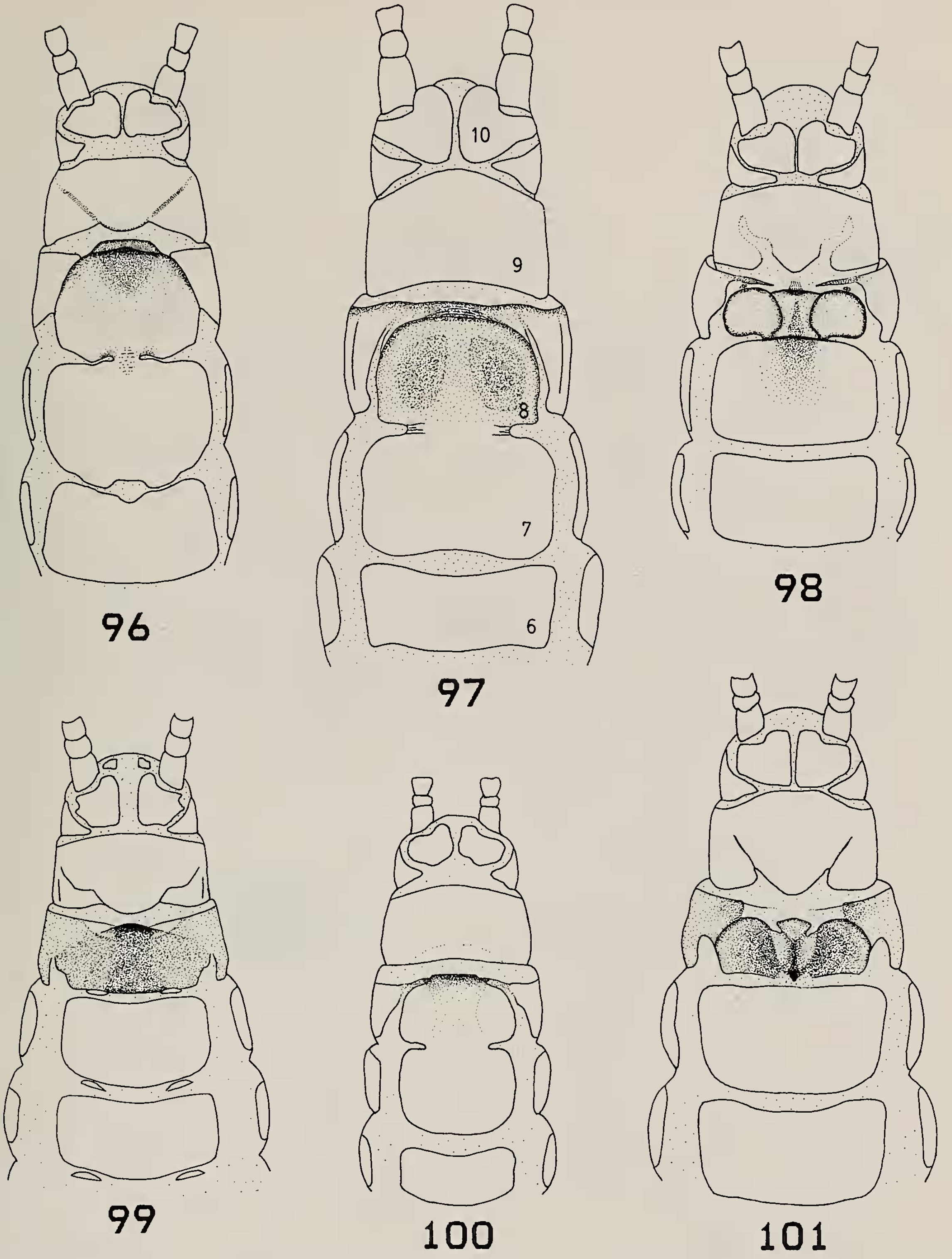

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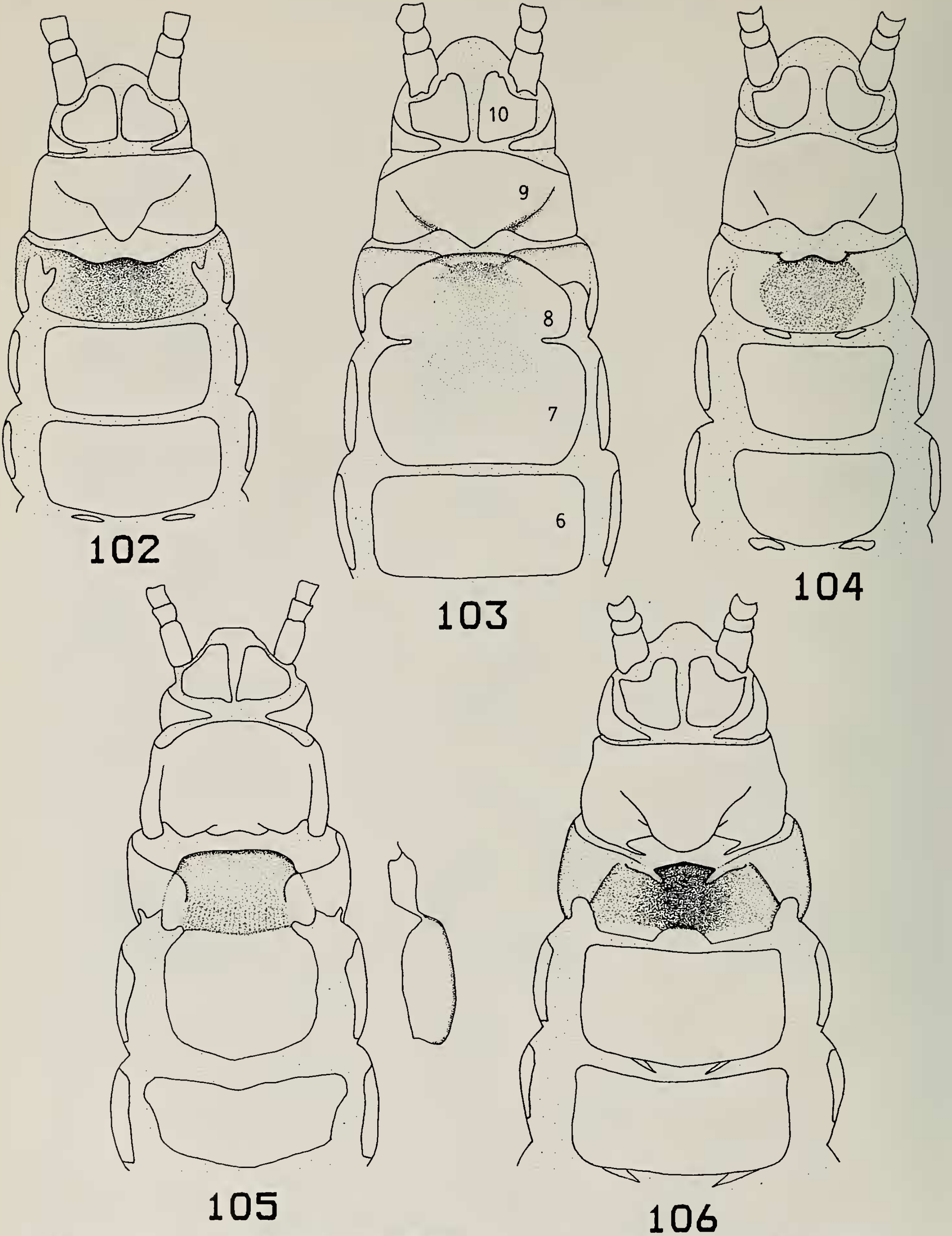

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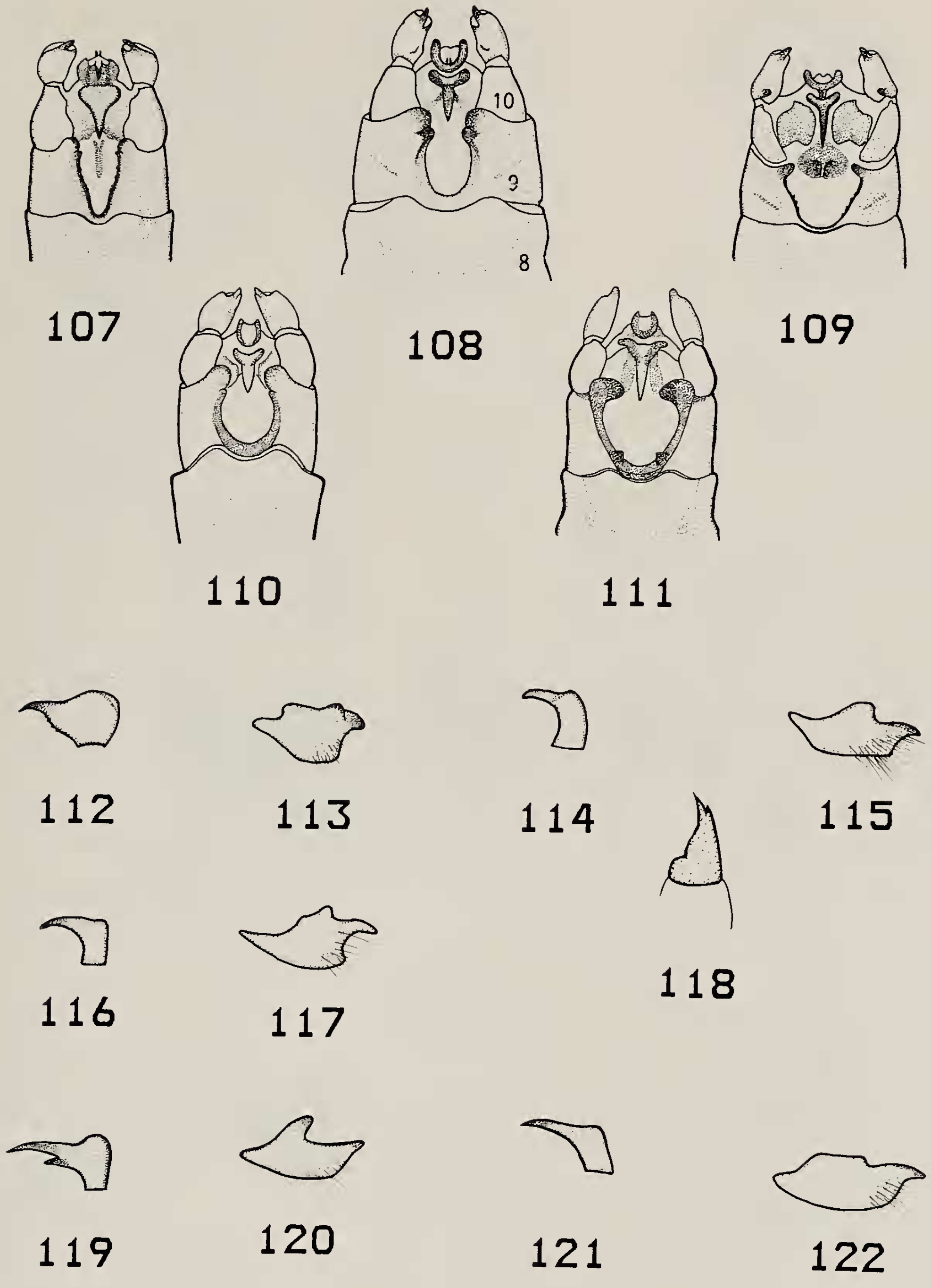

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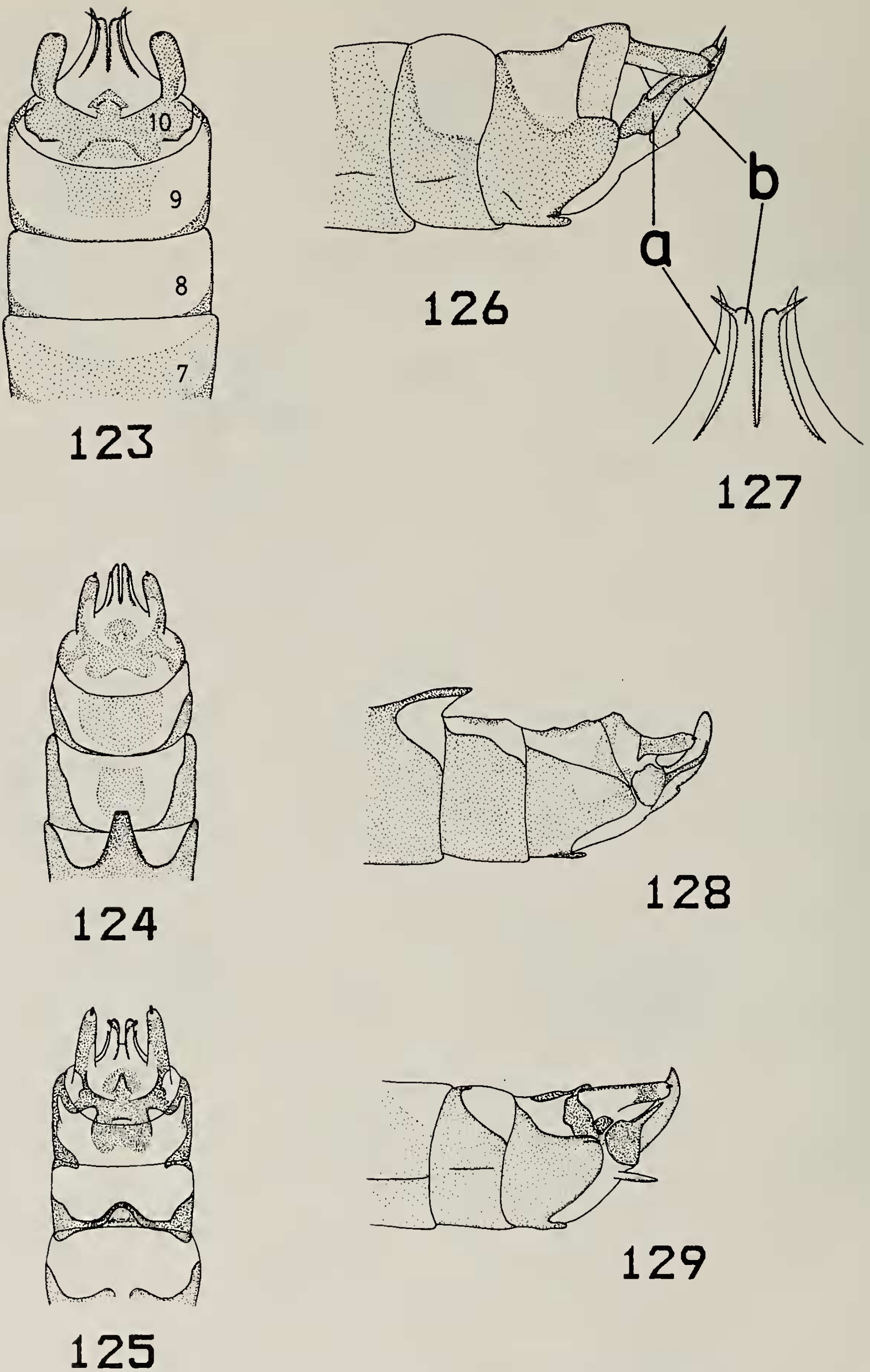

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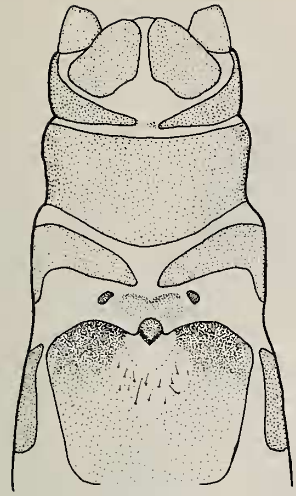

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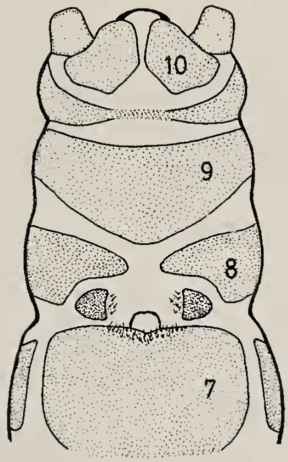

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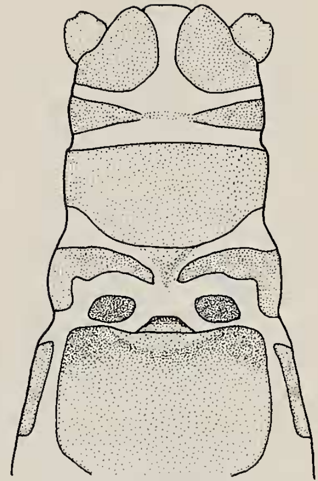

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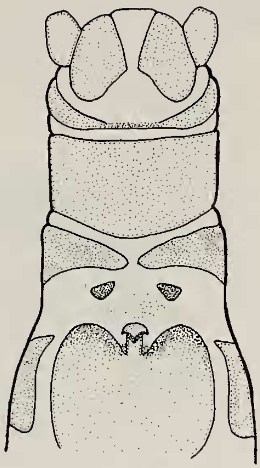

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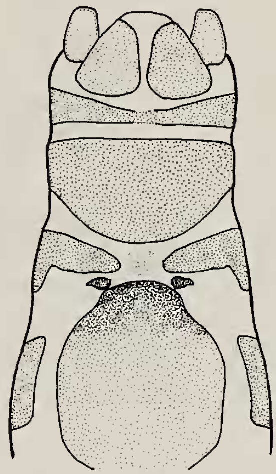

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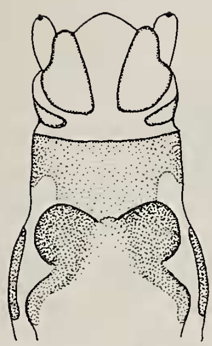

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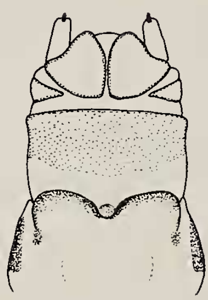

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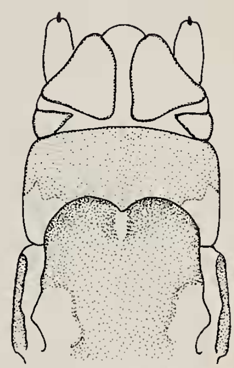

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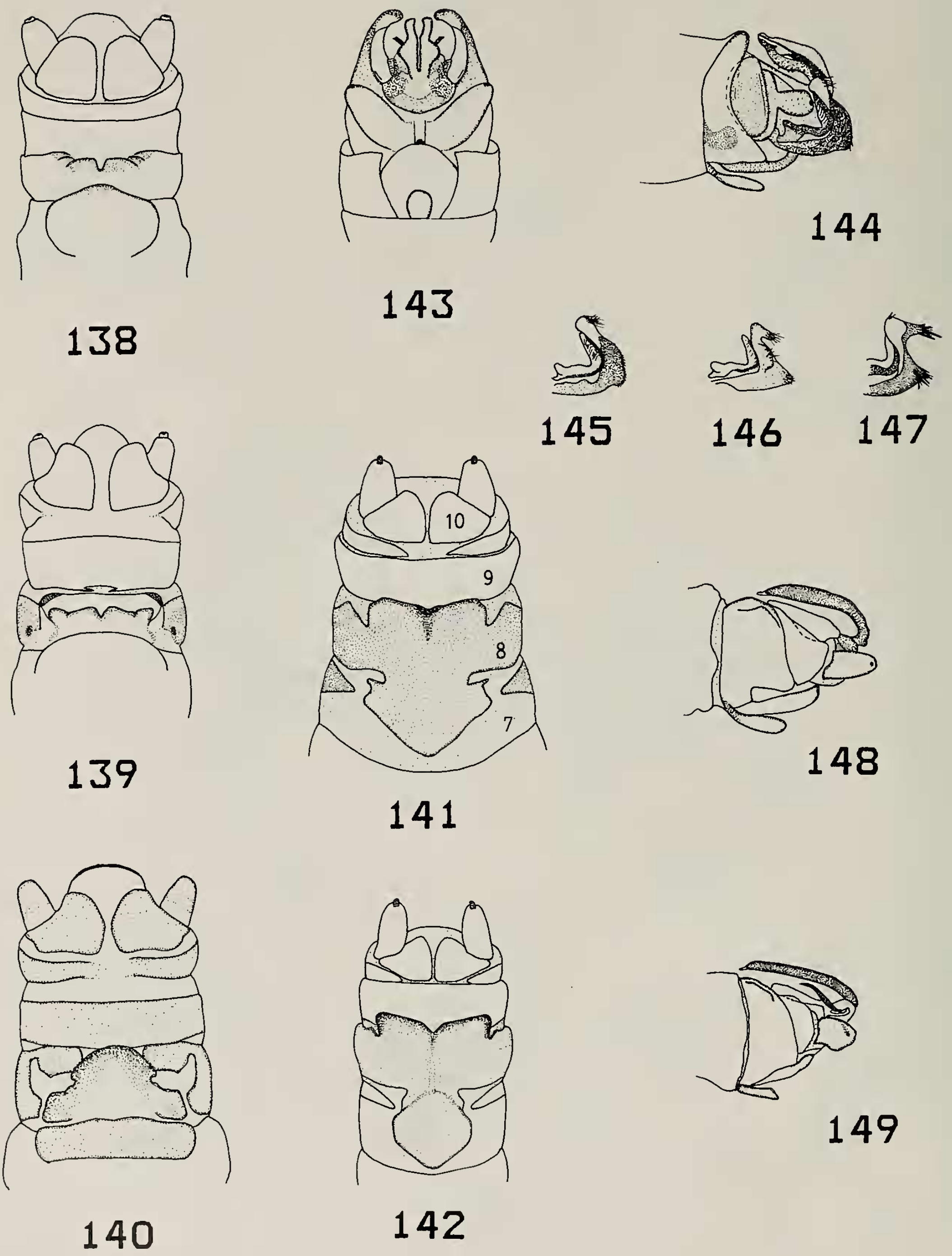

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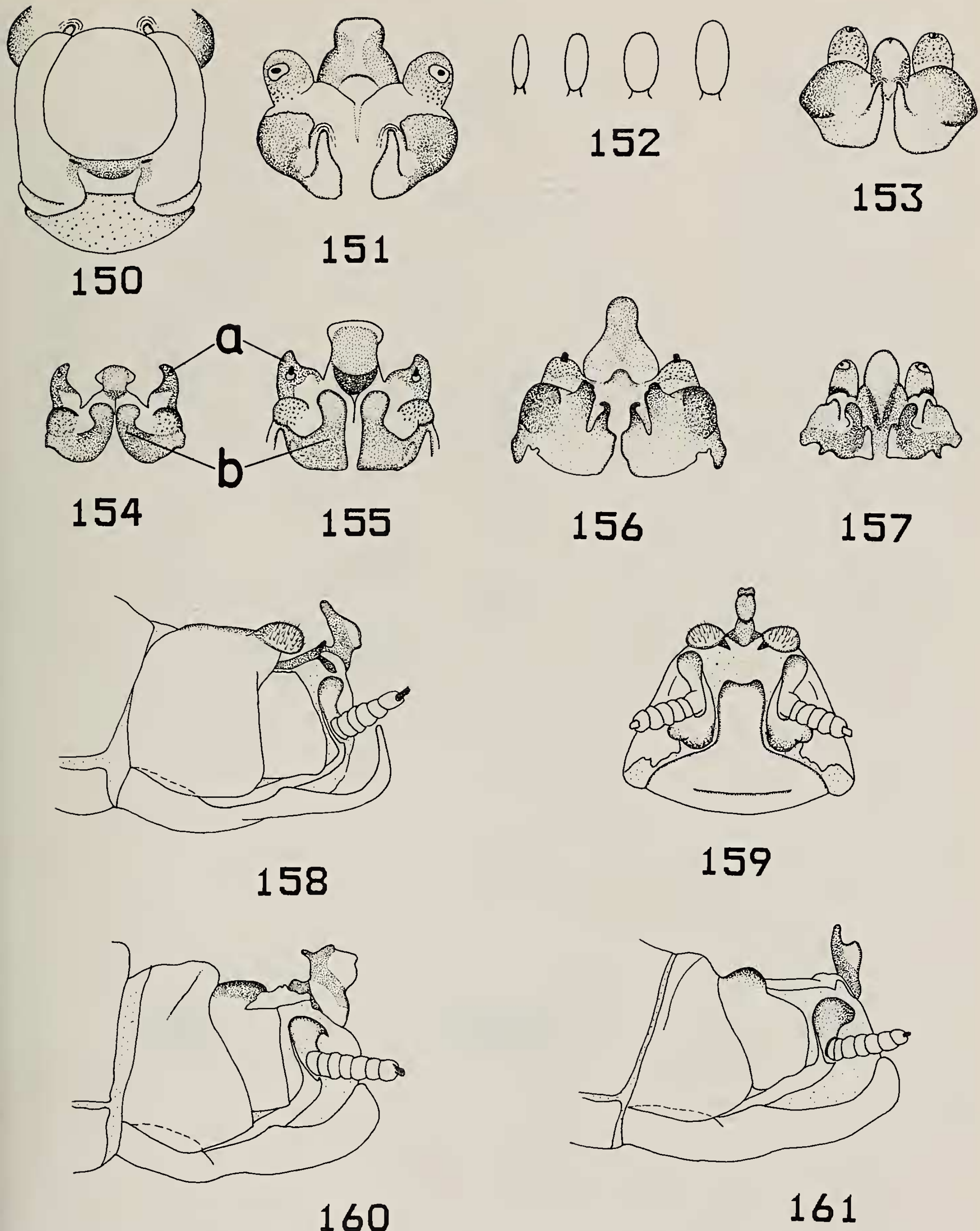

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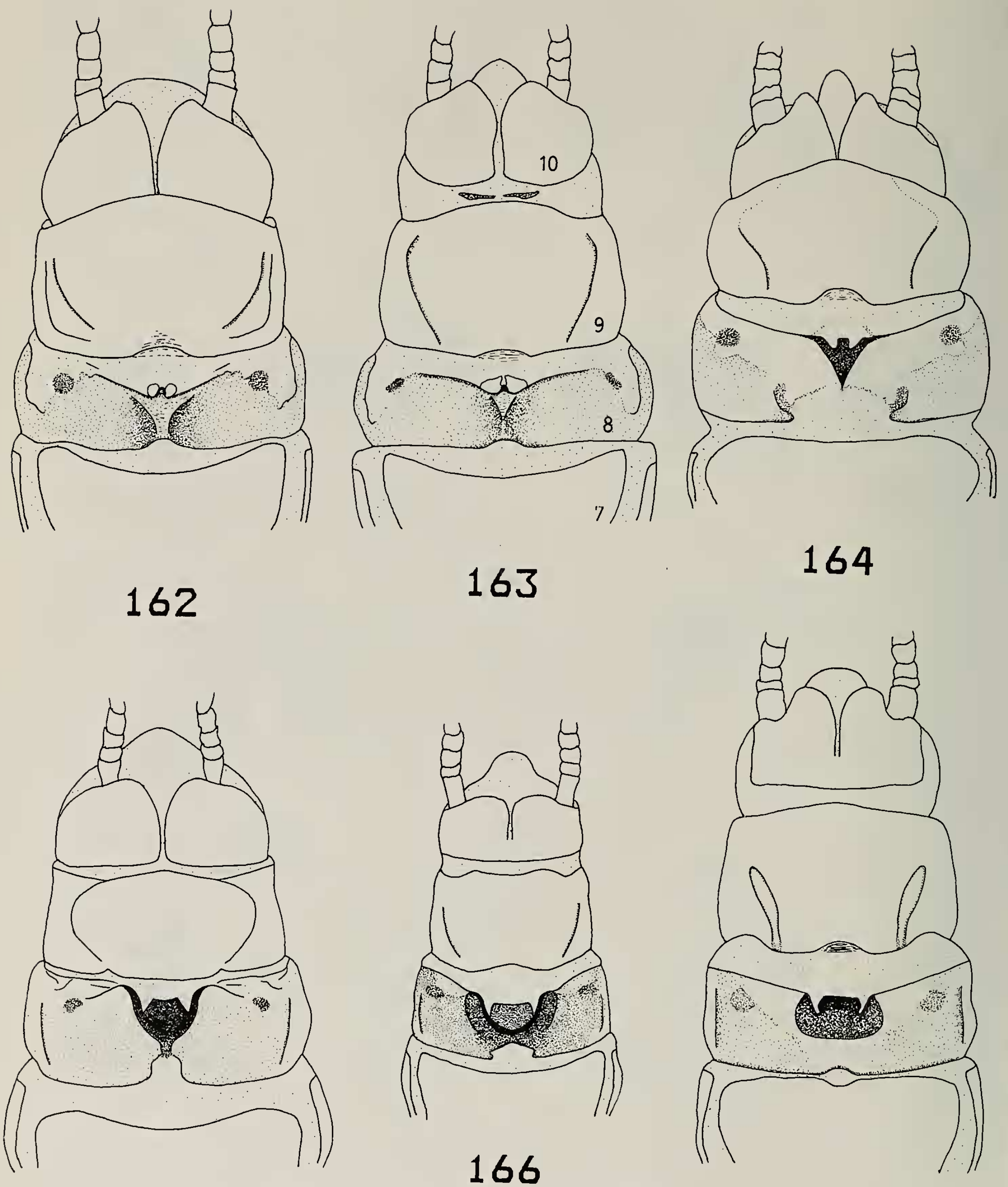

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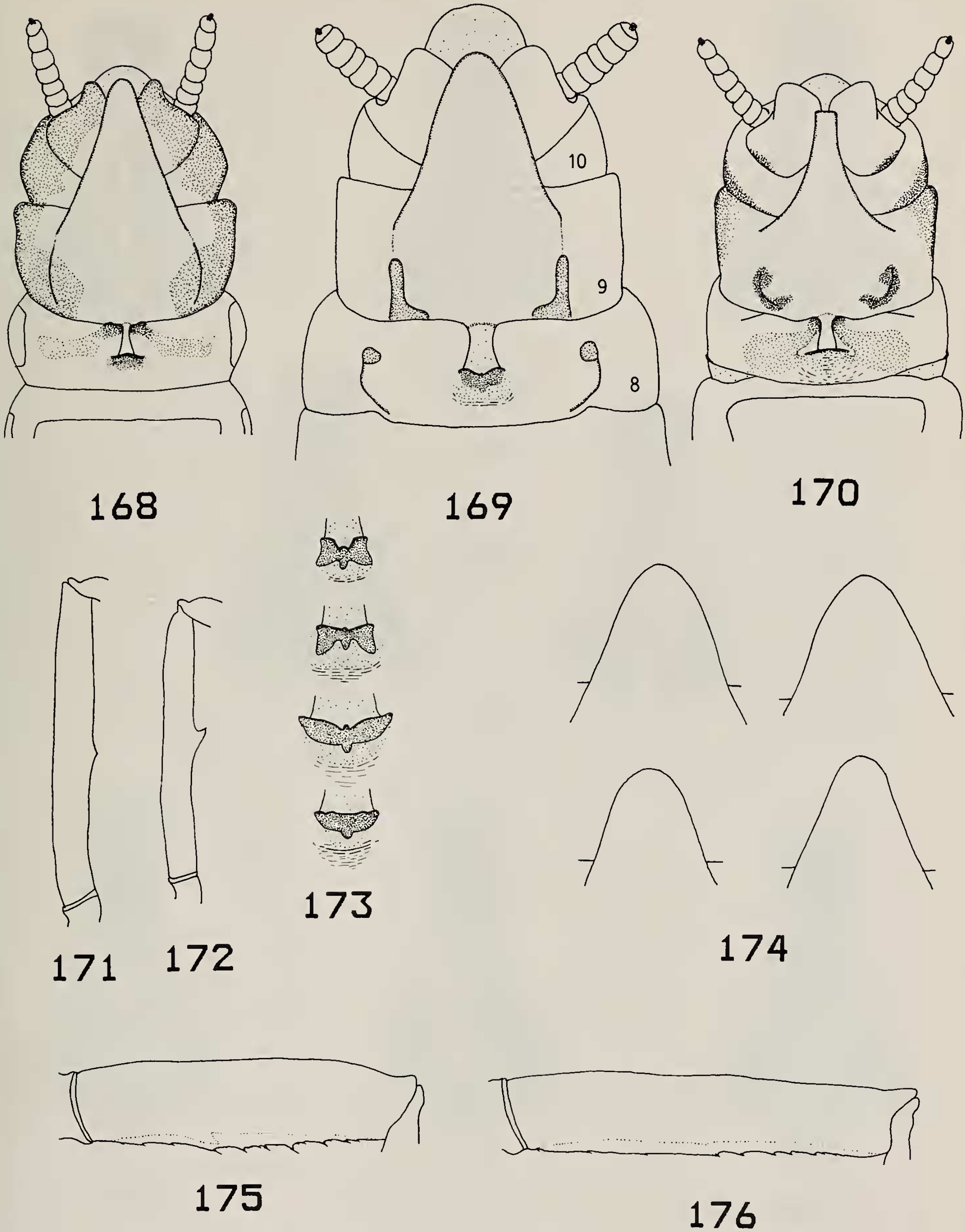

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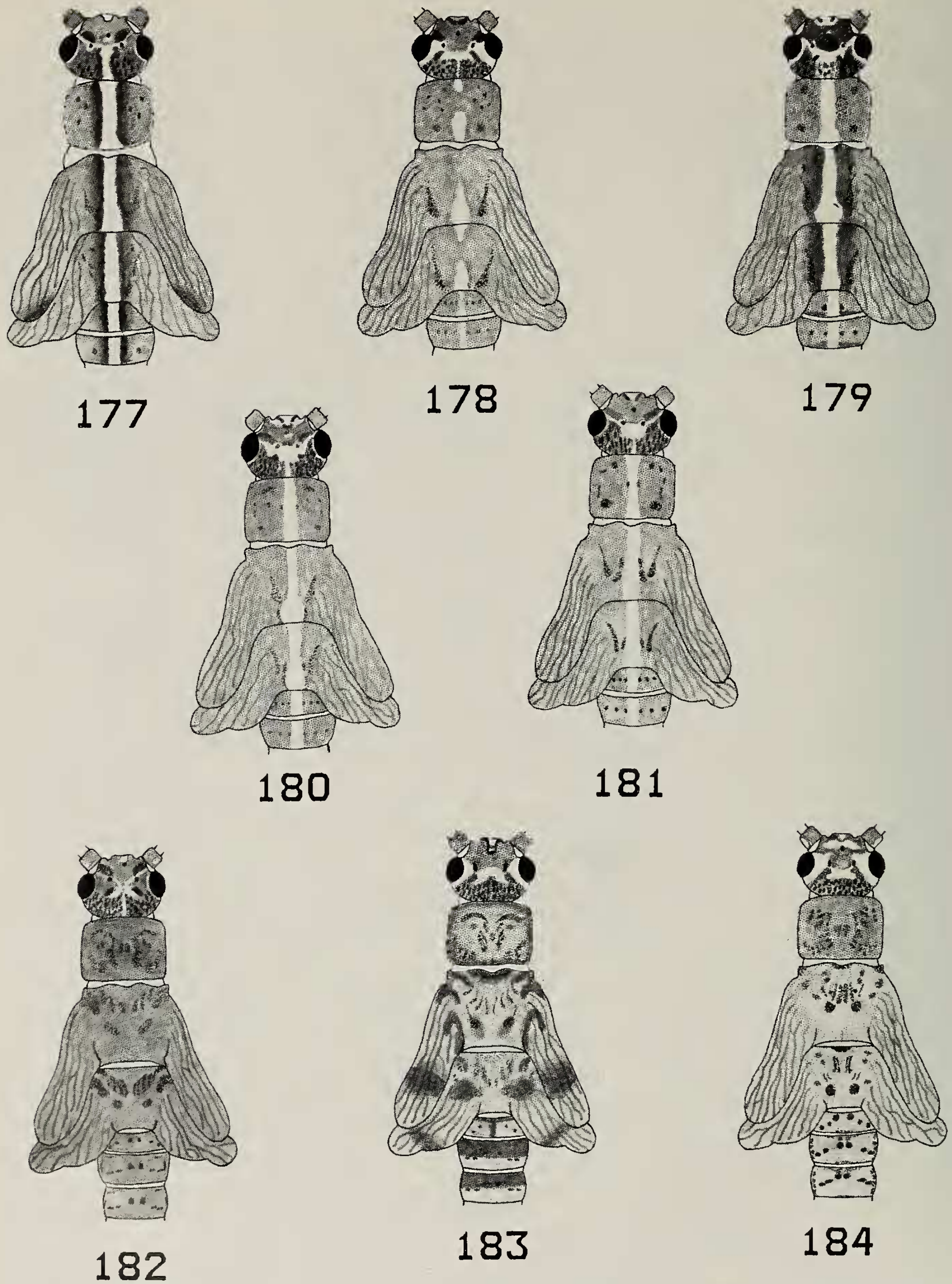

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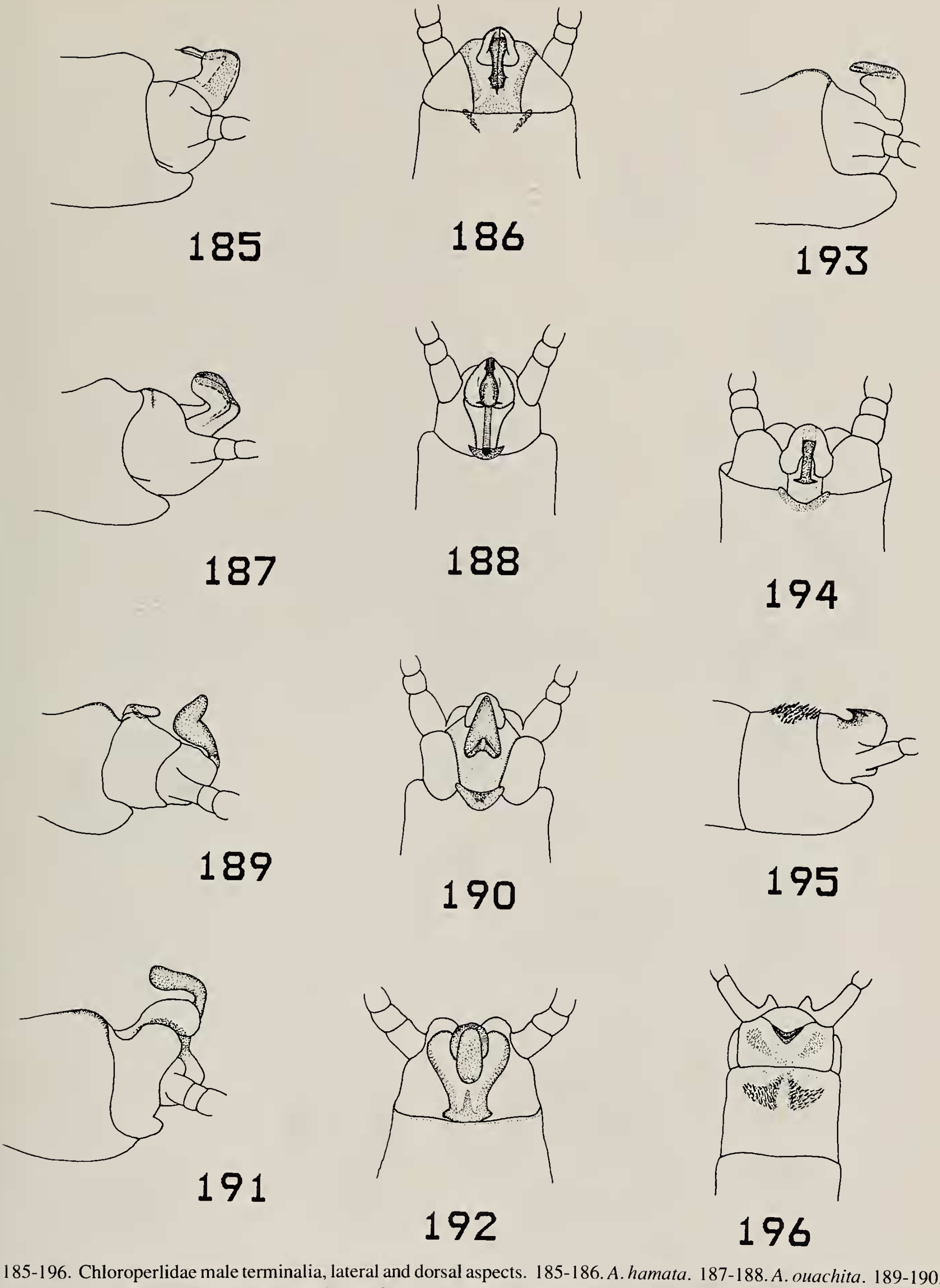

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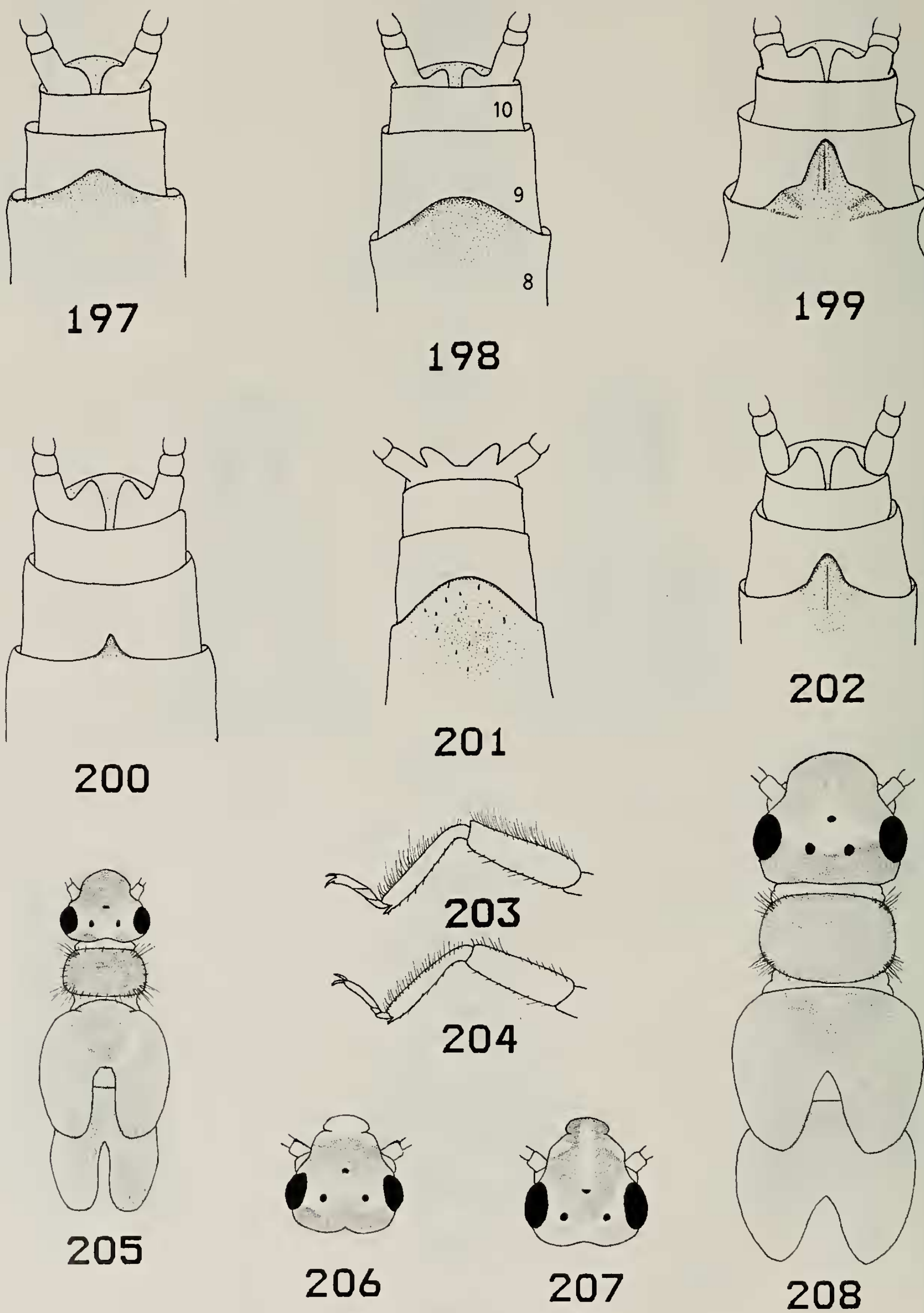

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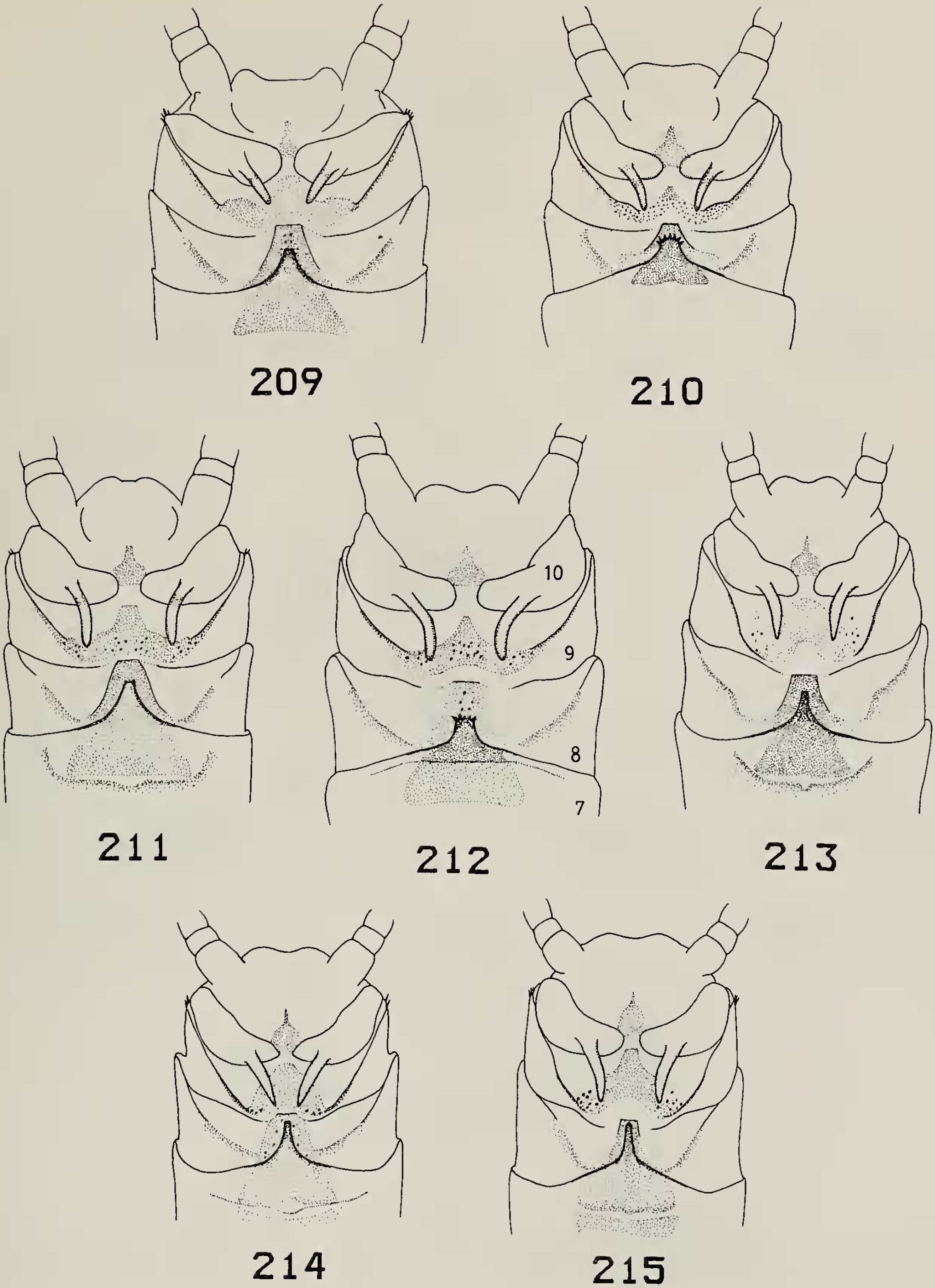
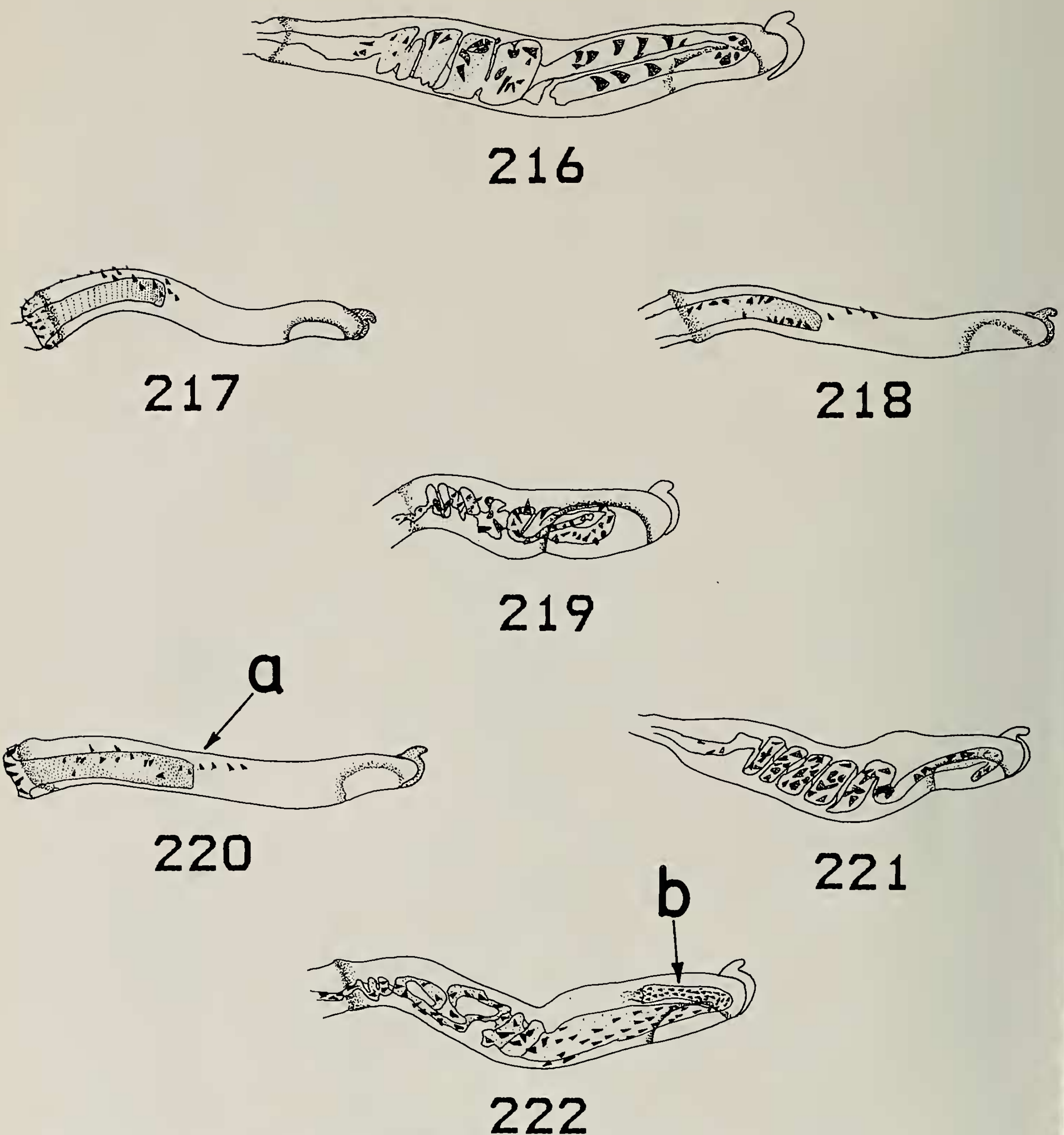
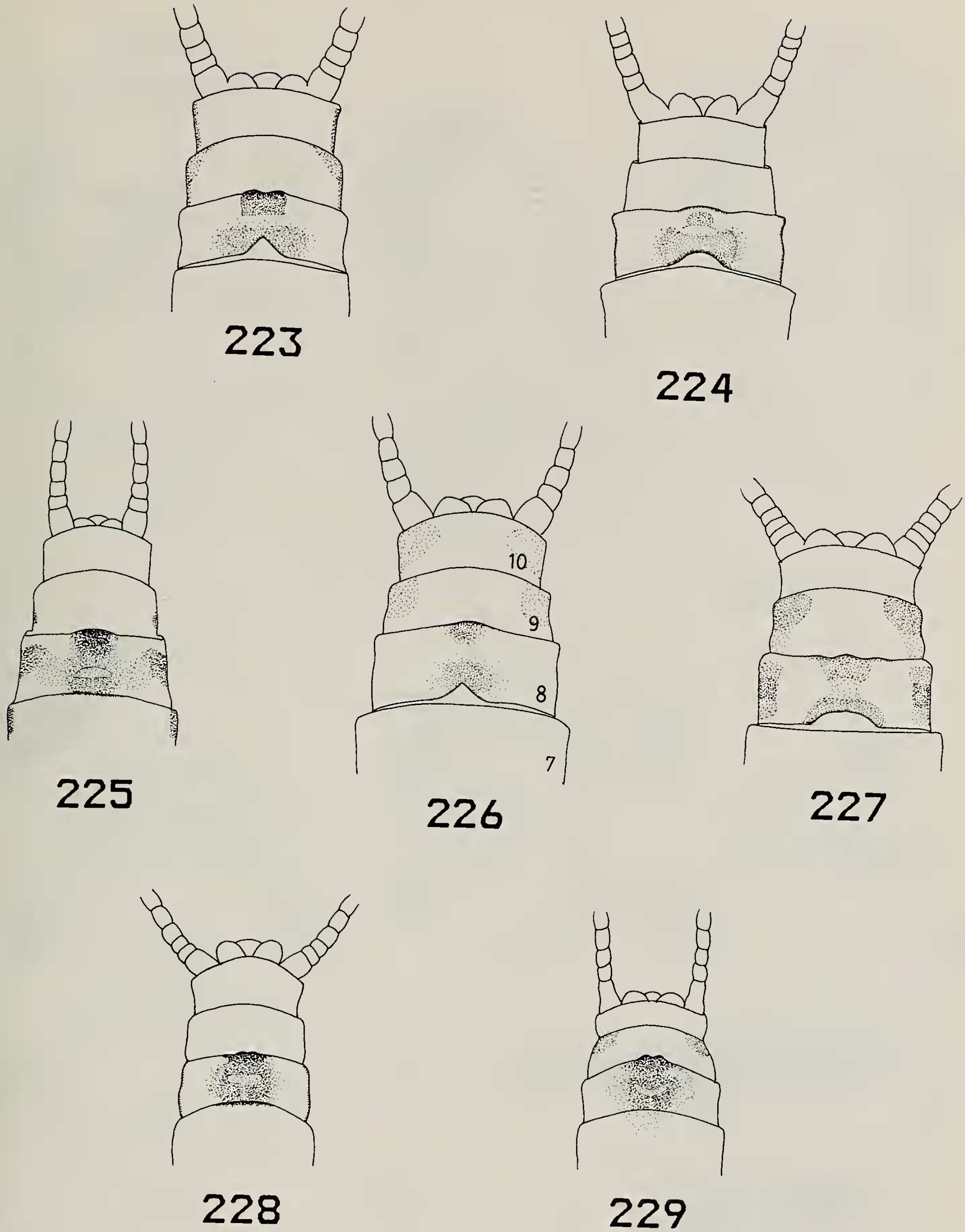


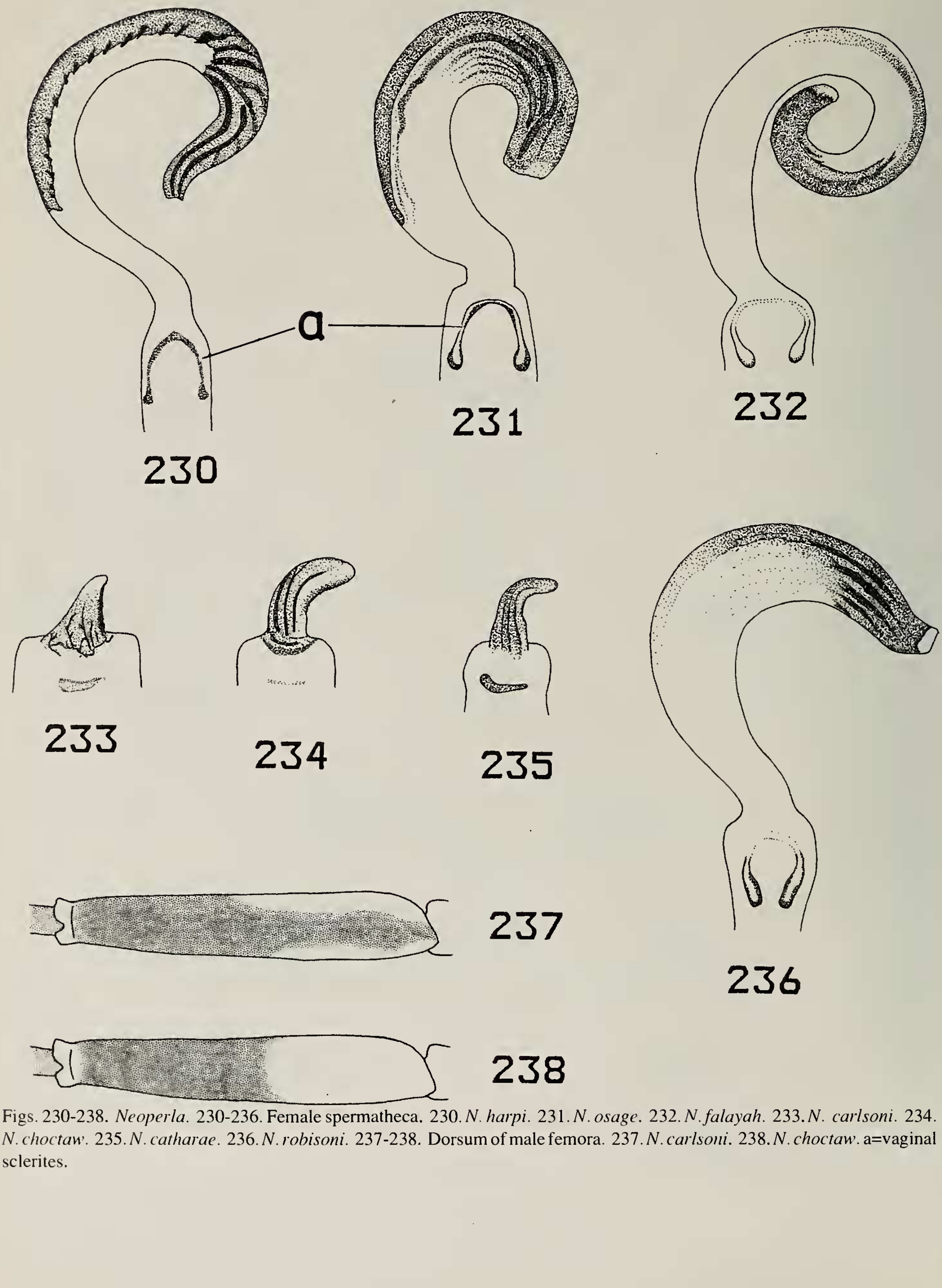
Figs. 209-215. *Neoperla* male terminal abdominal terga. 209. *N. osage*. 210. *N. harpi*. 211. *N. falayah*. 212. *N. robisoni*. 213. *N. choctaw*. 214. *N. catharae*. 215. *N. carlsoni*.



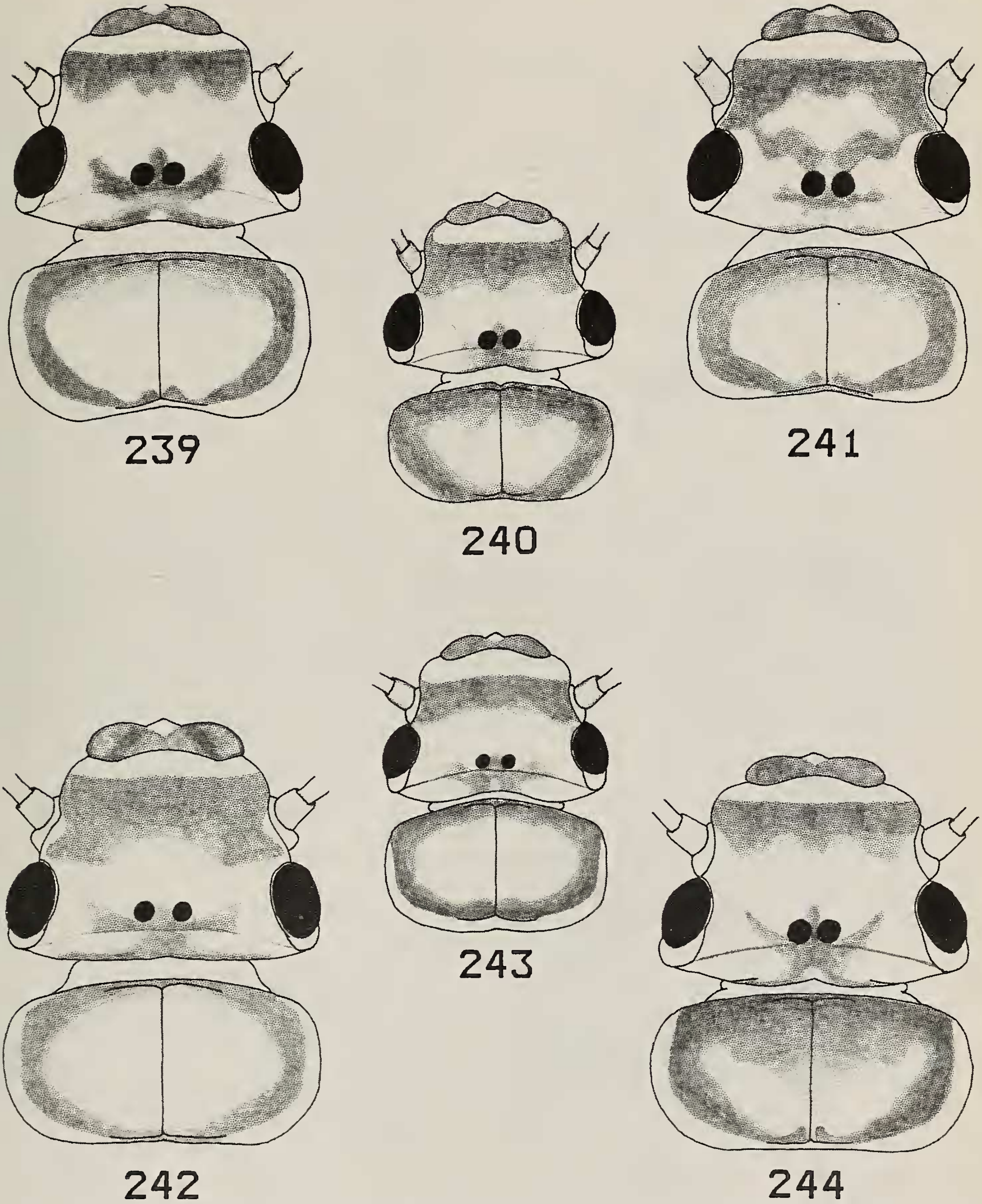
Figs. 216-222. *Neoperla* male aedeagus (not everted) and aedeagal tube. 216. *N. robisoni*. 217. *N. catharae*. 218. *N. choctaw*. 219. *N. osage*. 220. *N. carlsoni*. 221. *N. harpi*. 222. *N. falayah*. a=transparent aedeagal tube with external spines, b=small, dense apical spines of aedeagus.



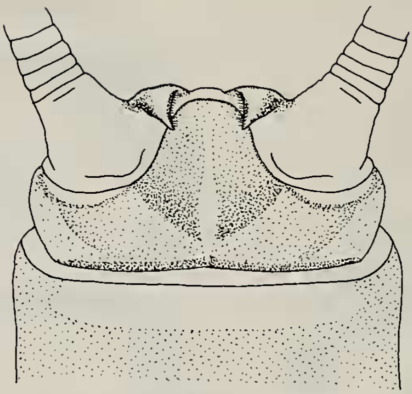
Figs. 223-229. *Neoperla* female terminal abdominal sterna. 223. *N. falayah*. 224. *N. harpi*. 225. *N. carlsoni*. 226. *N. robisoni*. 227. *N. osage*. 228. *N. catharae*. 229. *N. choctaw*.



Figs. 230-238. *Neoperla*. 230-236. Female spermatheca. 230. *N. harpi*. 231. *N. osage*. 232. *N. falayah*. 233. *N. carlsoni*. 234. *N. choctaw*. 235. *N. catharae*. 236. *N. robisoni*. 237-238. Dorsum of male femora. 237. *N. carlsoni*. 238. *N. choctaw*. a=vaginal sclerites.



Figs. 239-244. *Neoperla* nymphs. 239. *N. falayah*. 240. *N. choctaw*. 241. *N. harpi*. 242. *N. osage*. 243. *N. catharae*. 244. *N. robisoni*.



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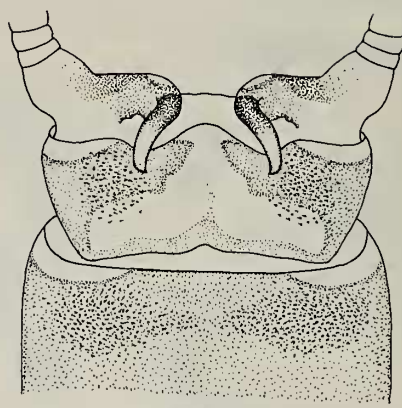

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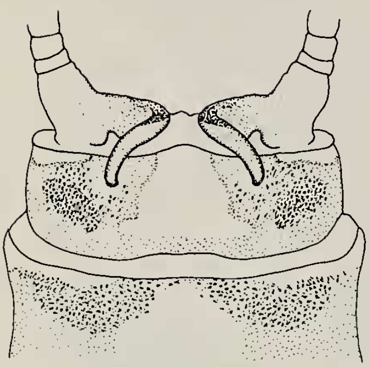

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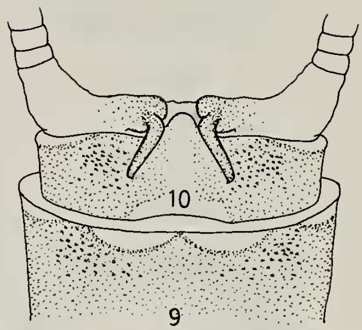

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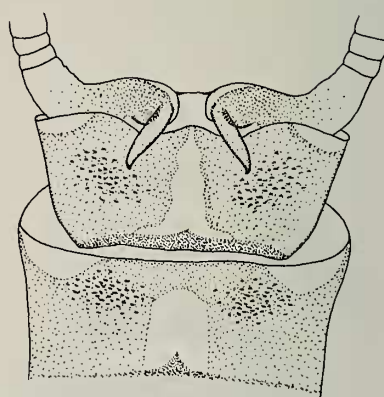

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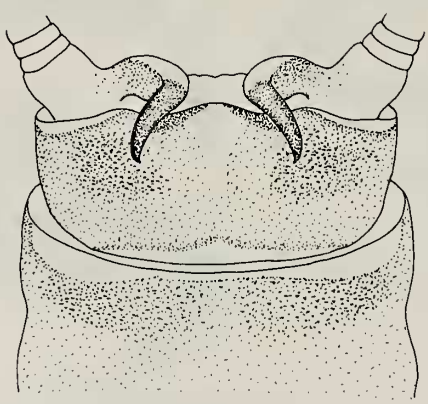

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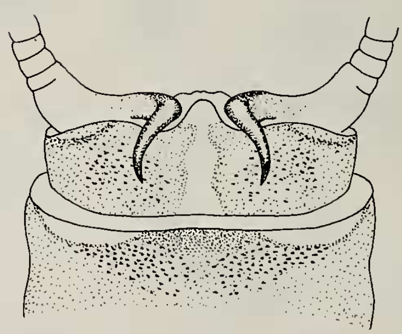

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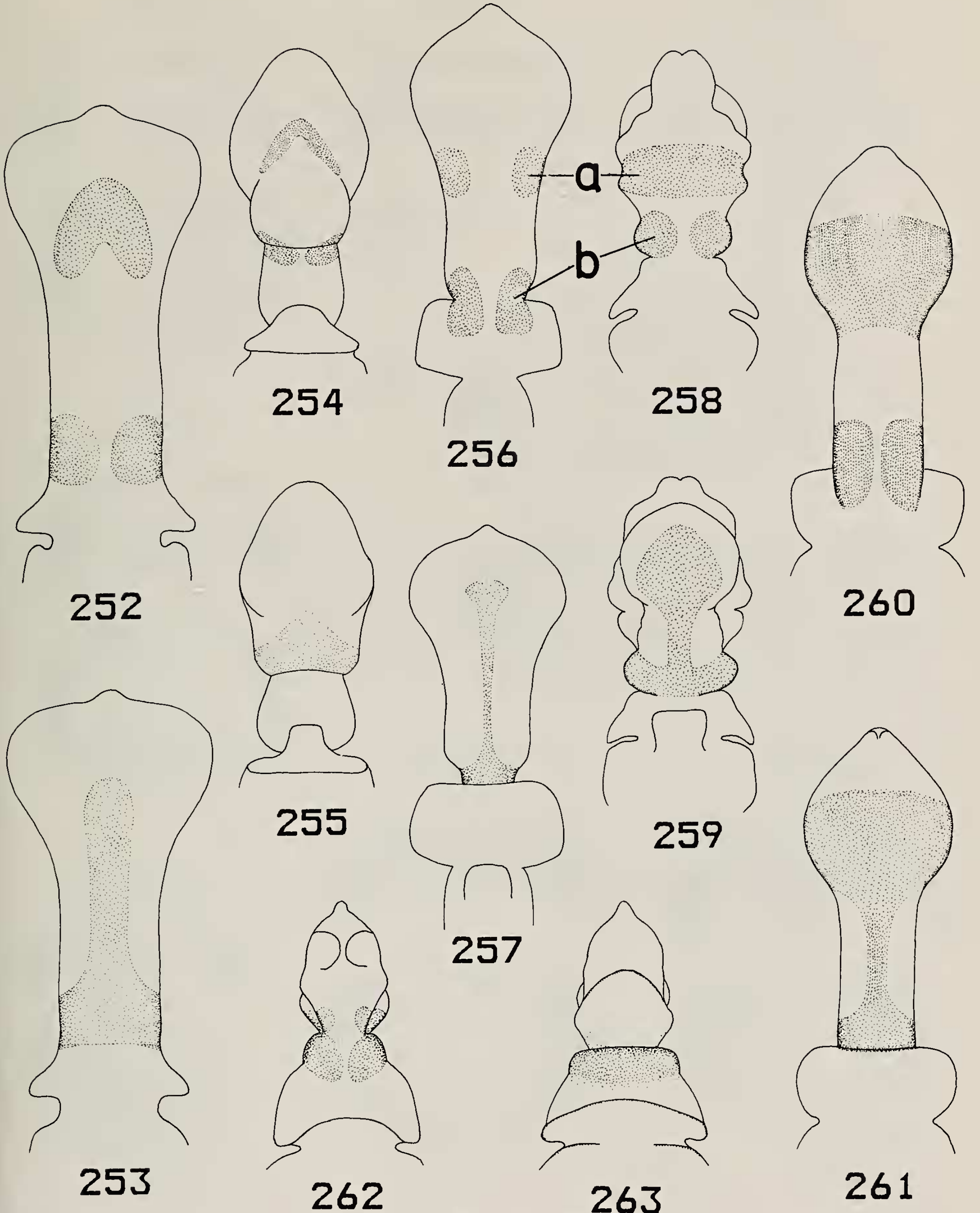
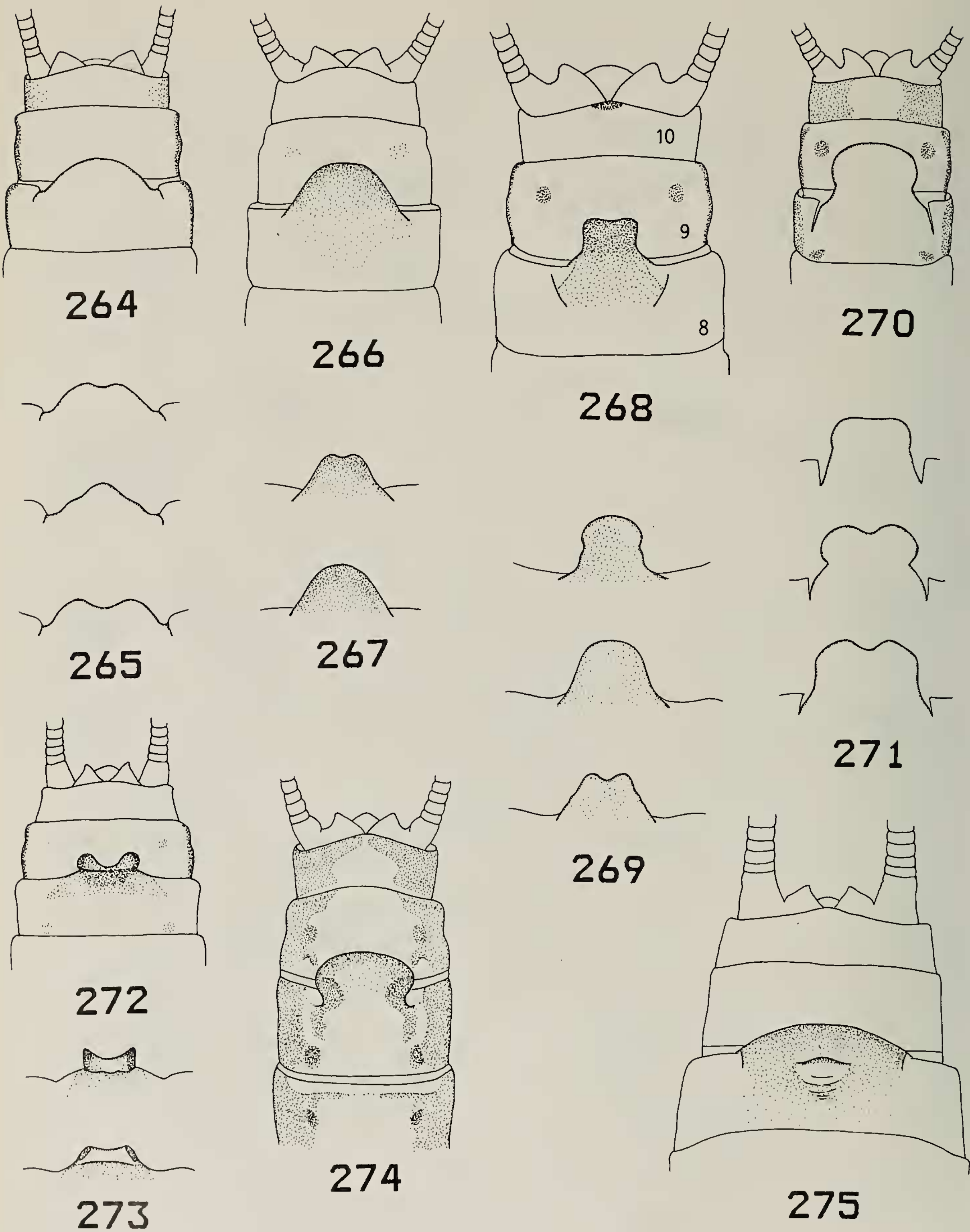
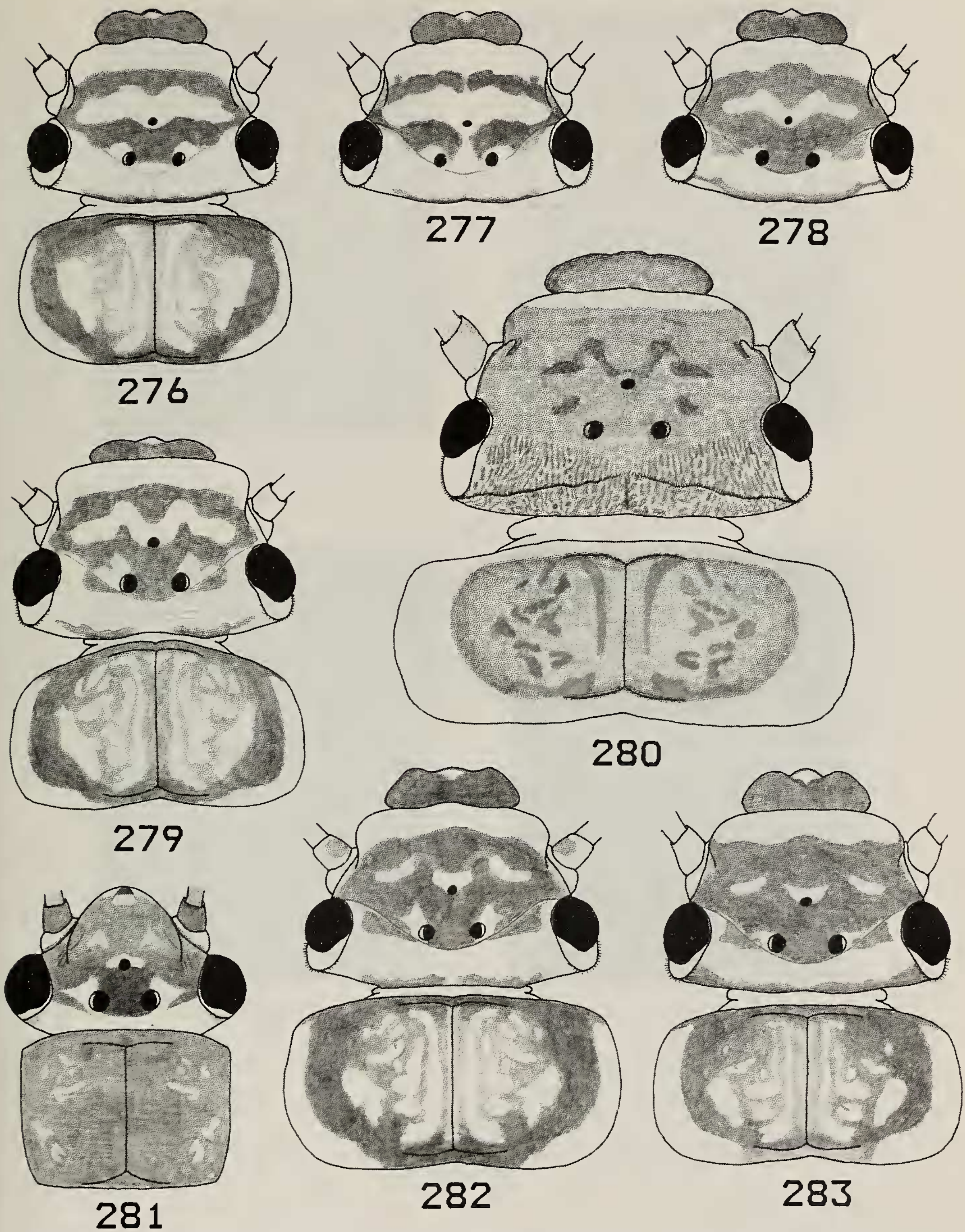
Figs. 245-251. Perlidae male terminal abdominal terga. 245. *Attaneuria ruralis*. 246. *Acroneuria ozarkensis*. 247. *A. evoluta*. 248. *A. internata*. 249. *A. perplexa*. 250. *A. mela*. 251. *A. filicis*.



Figs. 252-263. *Acroneuria* males, dorsal and ventral aspects of everted aedeagus. 252-253. *A. filicis*. 254-255. *A. evoluta*. 256-257. *A. mela*. 258-259. *A. perplexa*. 260-261. *A. ozarkensis*. 262-263. *A. internata*. a=apical spinule patch, b=basal spinule patch



Figs. 264-275. Perlidae female terminal abdominal sterna, and subgenital plate variations. 264-265. *Acroneuria perplexa*. 266-267. *A. filicis*. 268-269. *A. mela*. 270-271. *A. evoluta*. 272-273. *A. internata*. 274. *A. ozarkensis*. 275. *Attaneuria ruralis*.



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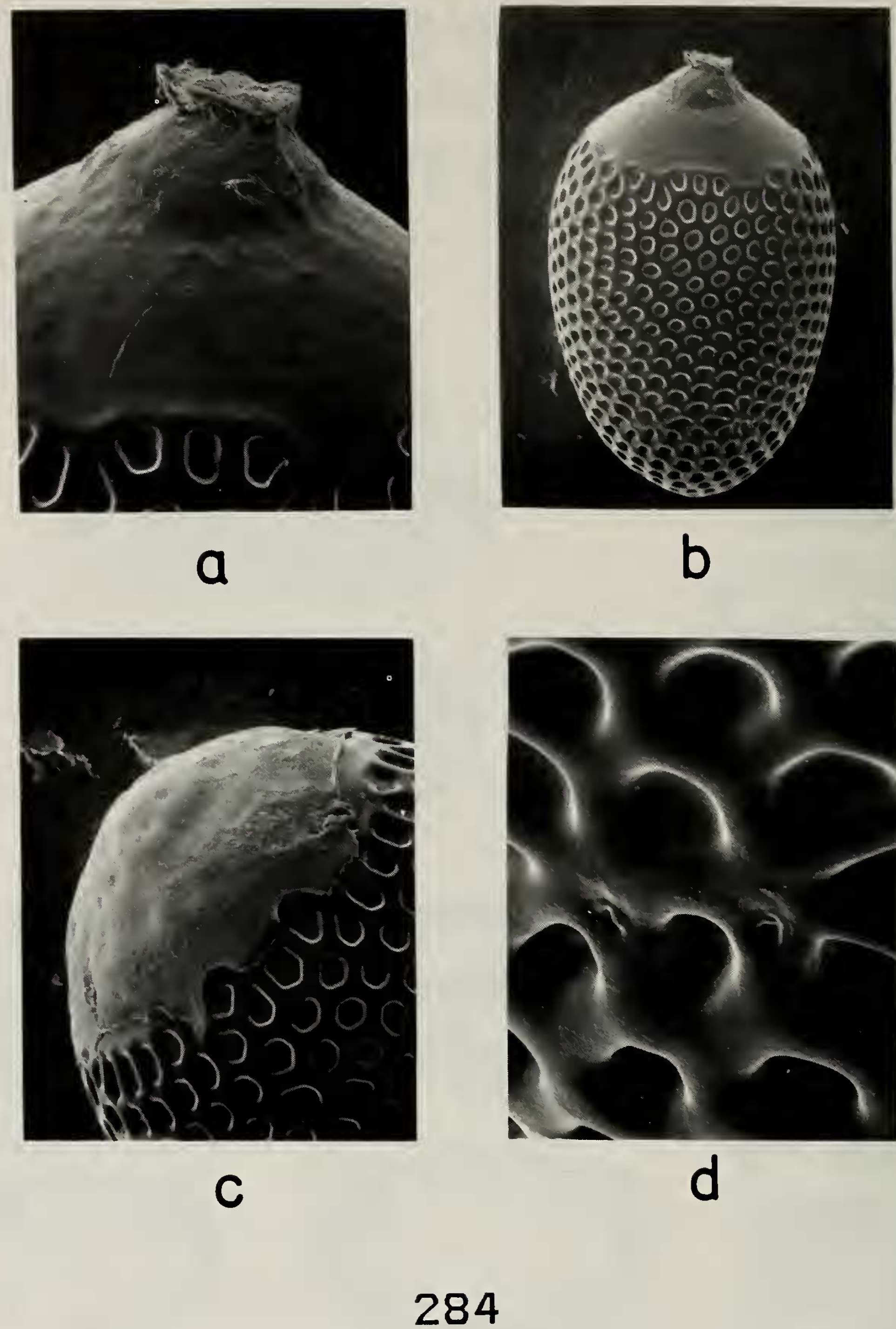
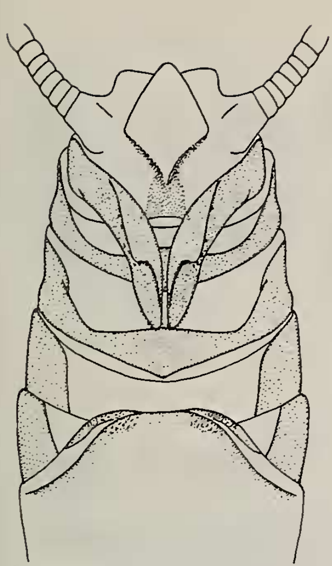


Figs. 284a-d. Egg of *A. ozarkensis.* a. 500X. b. 170X. c. 300X. d. 1300X.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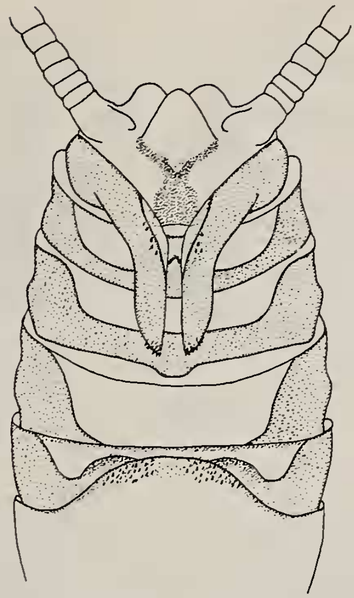
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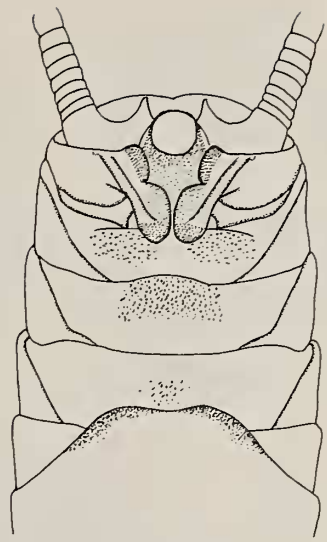
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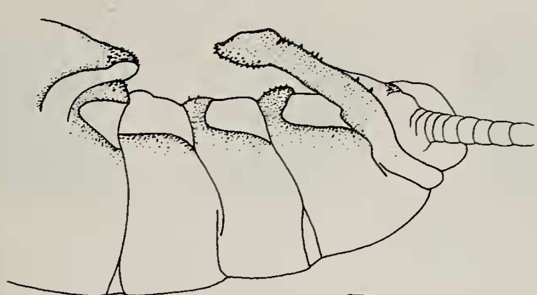
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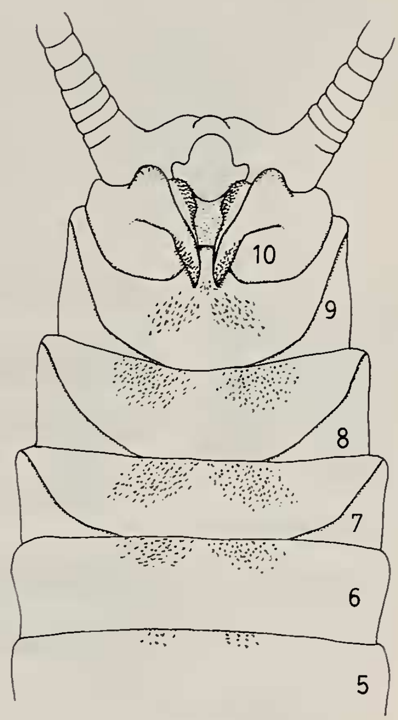

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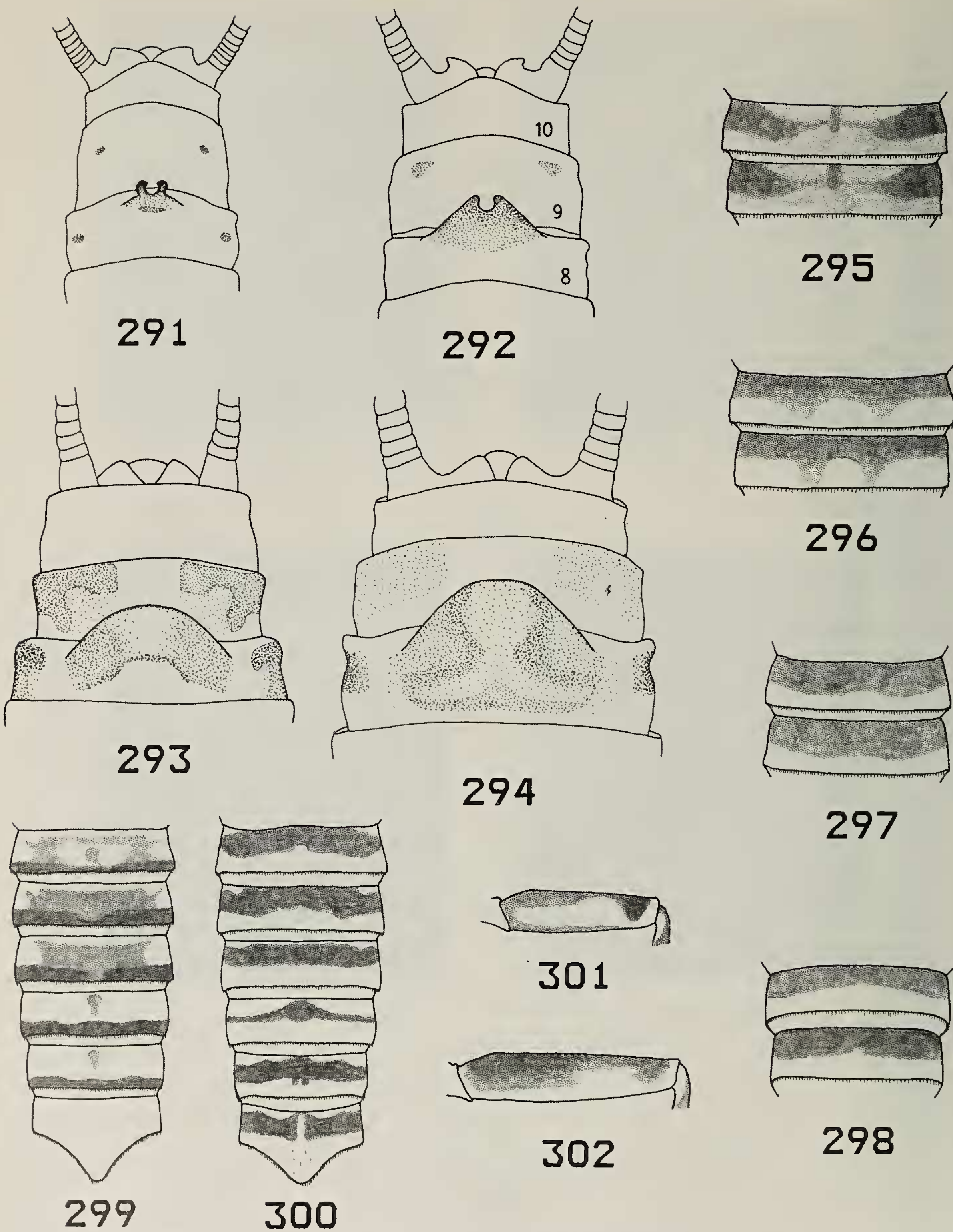
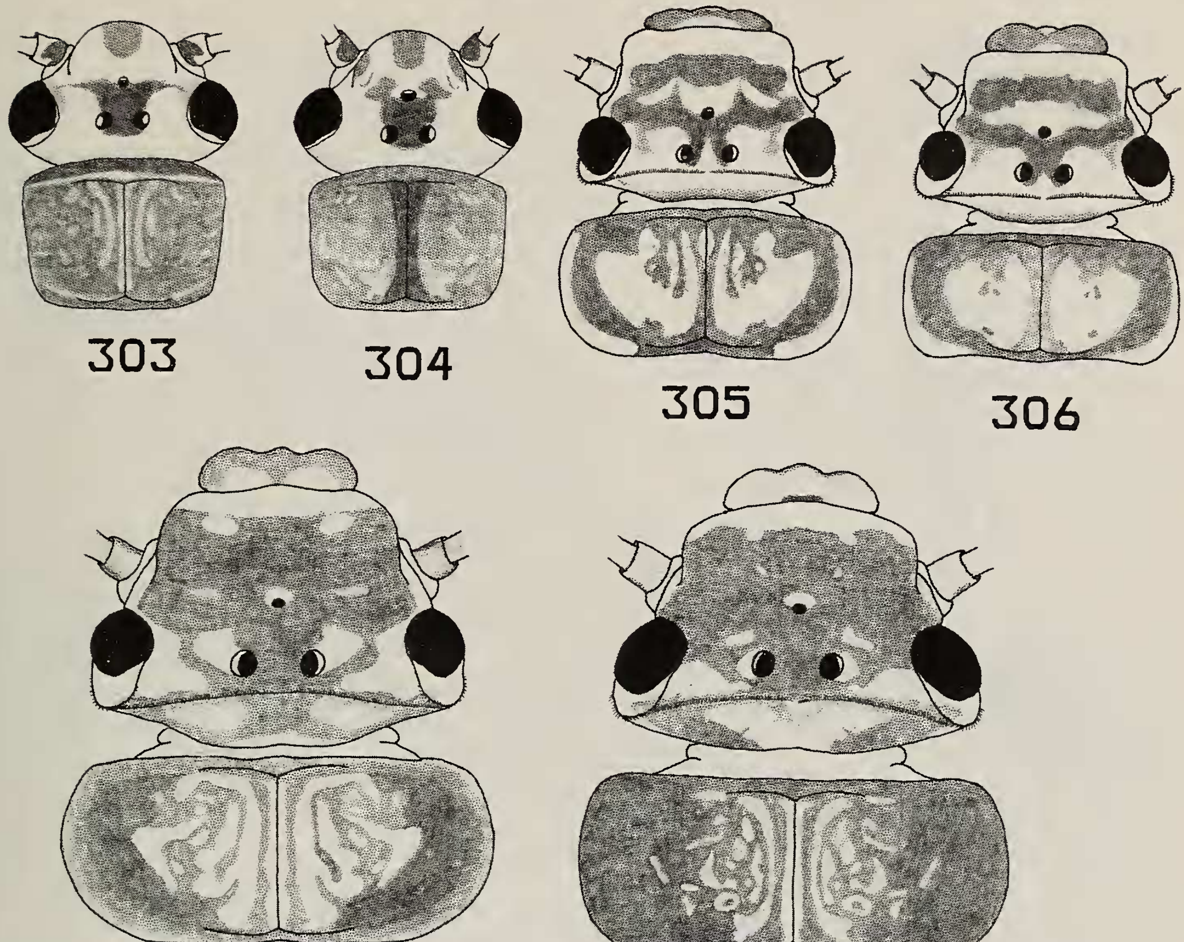
Figs. 285-290. *Agnetina* and *Paragnetina* males. 285- 288. Terminal abdominal terga. 285. *A. flavescens*. 286. *A. capitata*. 287. *P. media*. 288. *P. kansensis*. 289-290. Terminalia. 289. *A. flavescens*. 290. *A. capitata*.



Figs. 291-302. *Acroneuria*, *Agnetina* and *Paragnetina*. 291-294. Female abdominal sterna. 291. *P. media*. 292. *P. kansensis*. 293. *Agnetina* flavescens. 294. *A. capitata*. 295-300. Nymphal abdominal terga. 295. *Acroneuria mela*. 296. *A. filicis*. 297. *A. perplexa*. 298. *A. evoluta*. 299. *Agnetina capitata*. 300. *A. flavescens*. 301-302. Adult femora. 301. *A. capitata*. 302. *A. flavescens*.



Figs. 303-311. Perlidae head and pronotal patterns. 303-304. *Agnetina* adults. 303. *A. flavescens*. 304. *A. capitata*. 305-306. *Agnetina* nymphs. 305. *A. flavescens*. 306. *A. capitata*. 307-308. *P. media* nymph variants. 309. *P. kansensis* nymph. 310-311. *Paragnetina* adult. 310. *P. media*. 311. *P. kansensis*.

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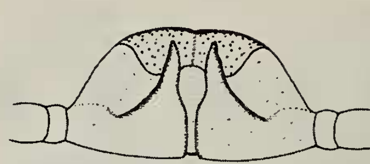

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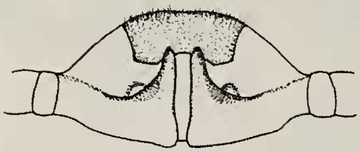

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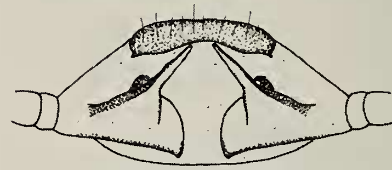

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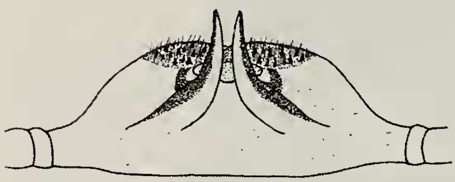

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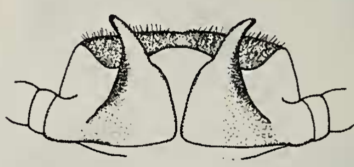

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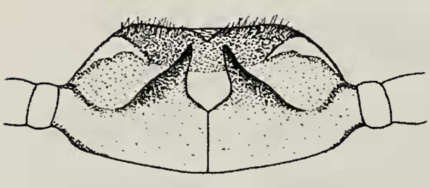

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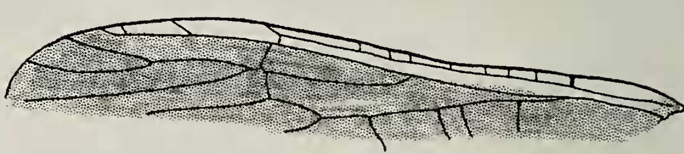

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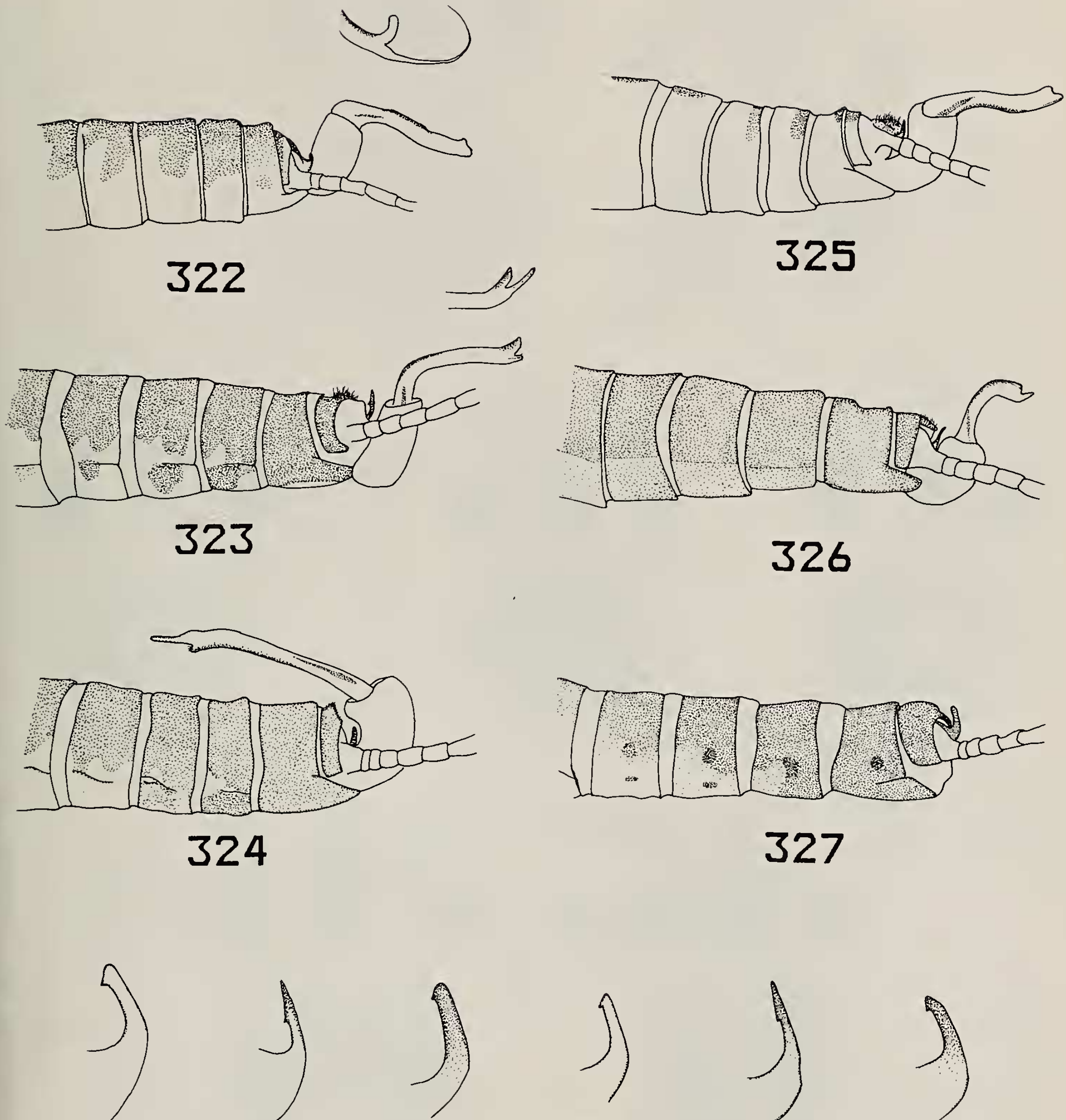
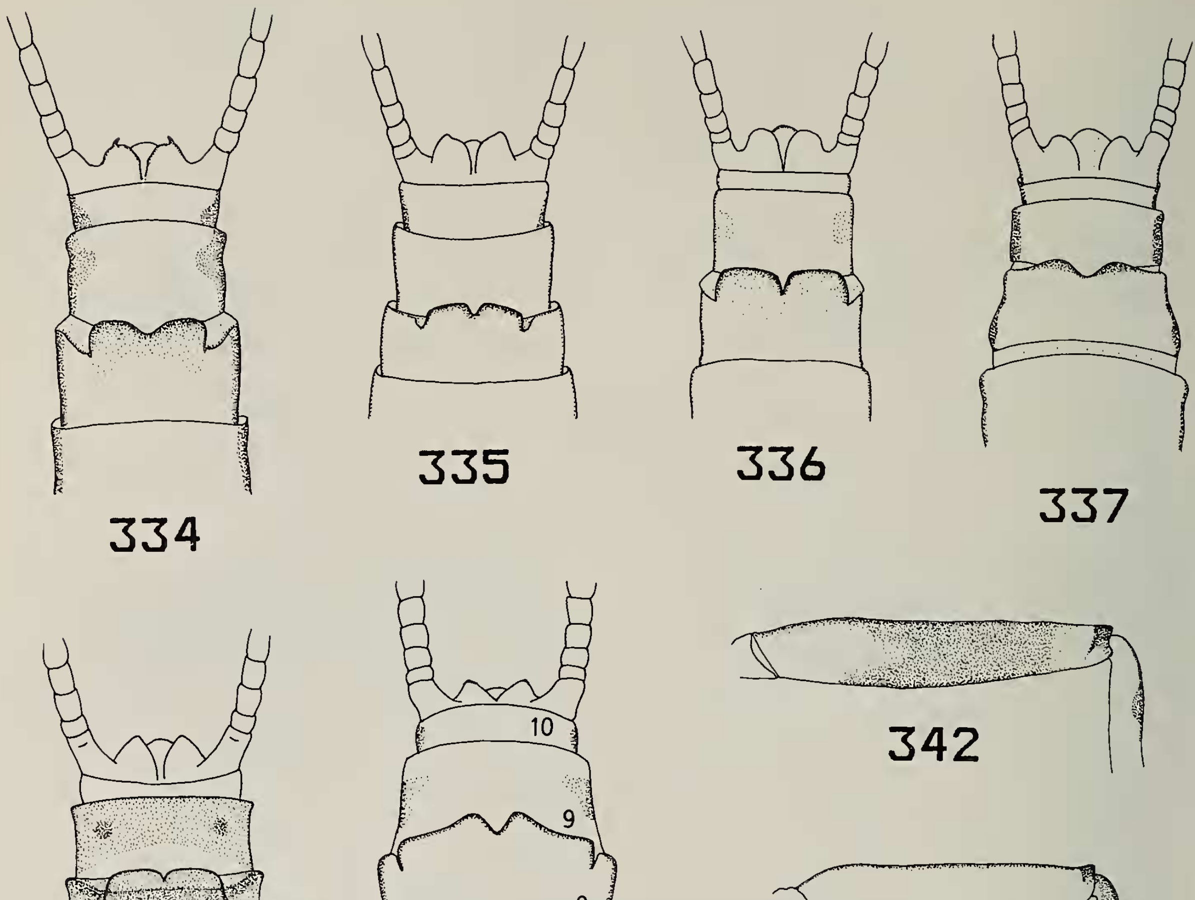
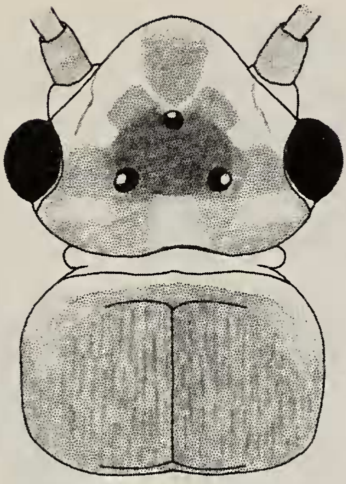
Figs. 312-321. *Perlesta*. 312-318. Rear aspect of male paraprocts. 312-313. *P. decipiens* and variant. 314. *P. cinctipes*. 315. *P. fusca*. 316. *P. shubuta*. 317. *P. browni*. 318. *P. baumanni*. 319-321. Forewing costal region. 319. *P. decipiens*. 320. *P. baumanni*. 321. *P. fusca*.



Figs. 322-333. *Perlesta* males. 322-327. Abdomen and everted aedeagus. 322. *P. decipiens*. 323. *P. cinctipes*. 324. *P. fusca*. 325. *P. shubuta*. 326. *P. browni*. 327. *P. baumanni*. 328-333. Lateral aspect of paraproct. 328. *P. decipiens*. 329. *P. cinctipes*. 330. *P. fusca*. 331. *P. shubuta*. 332. *P. browni*. 333. *P. baumanni*.



Figs. 334-345. *Perlesta* females. 334-339. Abdominal sterna. 334. *P. browni*. 335. *P. shubuta*. 336. *P. decipiens*. 337. *P. baumanni*. 338. *P. cinctipes*. 339. *P. fusca*. 340-345. Femur and tibia. 340. *P. baumanni*. 341. *P. fusca*. 342. *P. cinctipes*. 343. *P. shubuta*. 344. *P. browni*. 345. *P. decipiens*.



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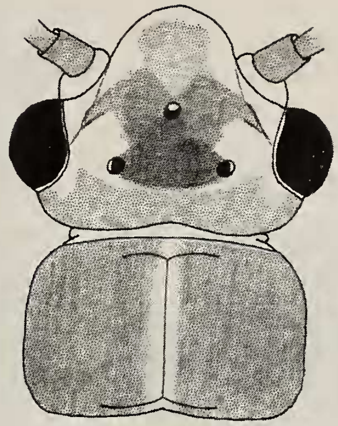

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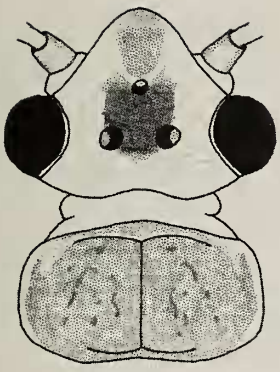

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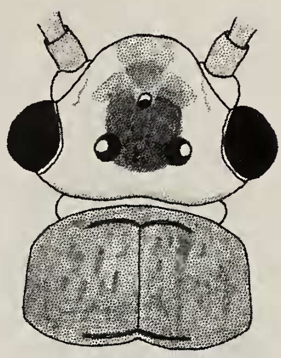

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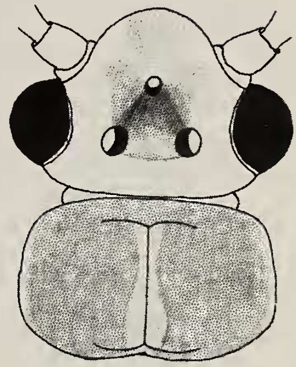

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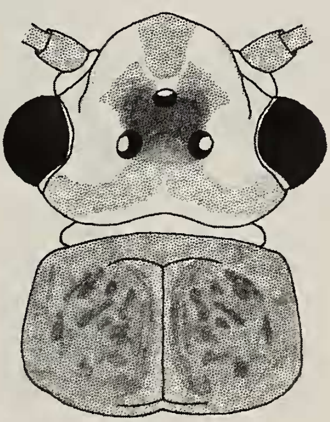

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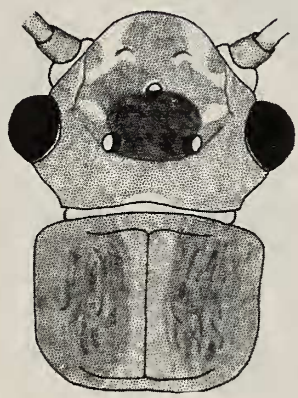

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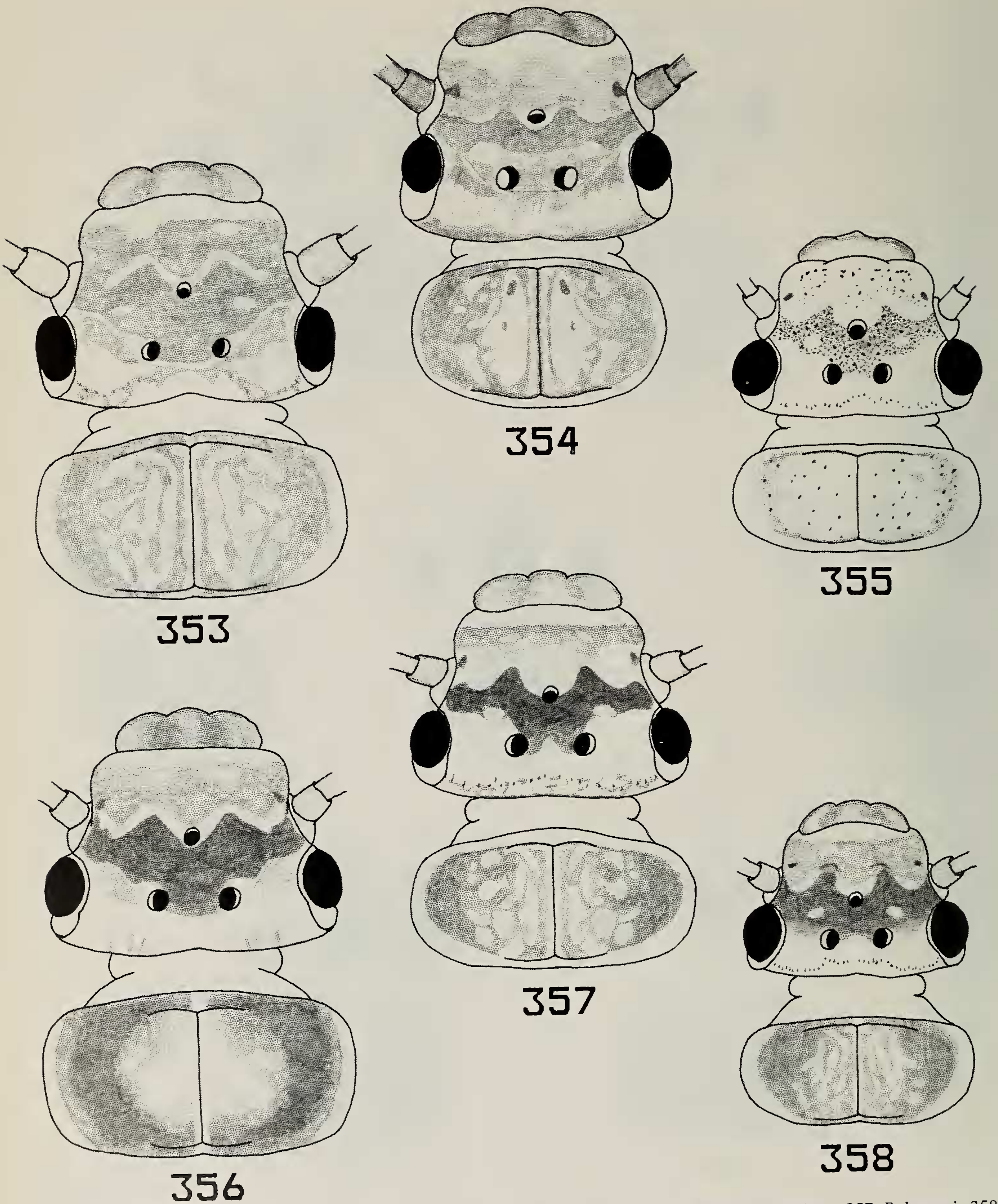
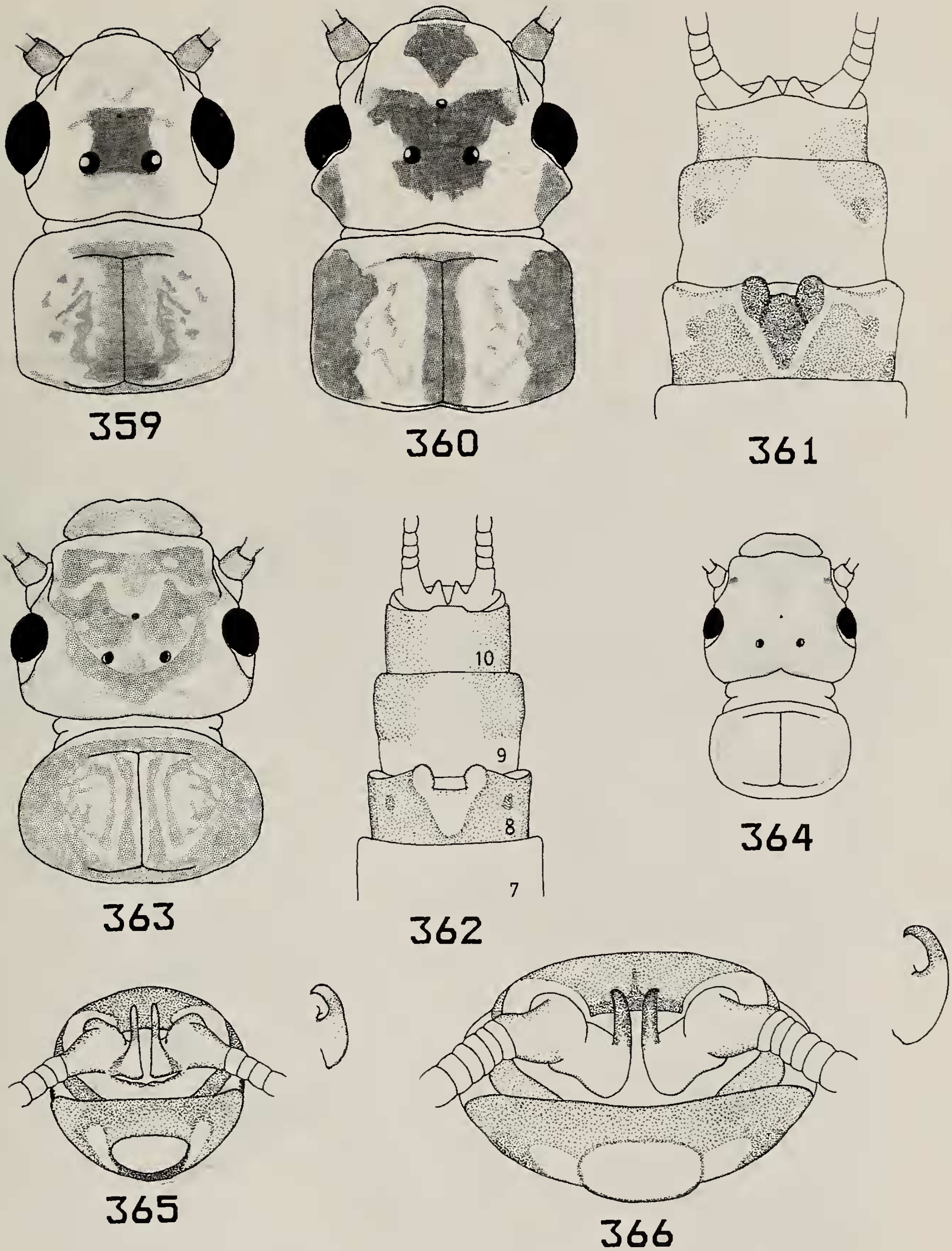
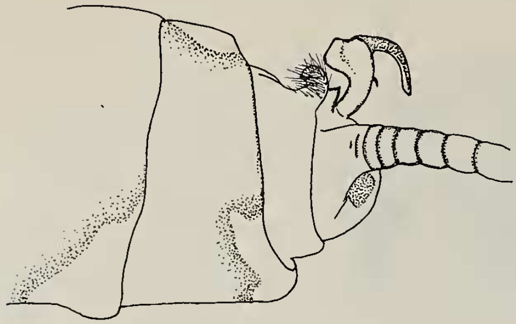
Figs. 346-352. *Perlesta* adults. 346. *P. fusca*. 347. *P. cinctipes*. 348. *P. shubuta*. 349. *P. decipiens*. 350. *P. shubuta* variant. 351. *P. browni*. 352. *P. baumanni*.



Figs. 353-358. *Perlesta* nymphs. 353. *P. fusca*. 354. *P. baumanni*. 355. *P. shubuta*. 356. *P. cinctipes*. 357. *P. browni*. 358. *P. decipiens*.



Figs. 359-366. *Perlinella*. 359-360. Adult head and pronotum. 359. *P. ephyre*. 360. *P. drymo*. 361-362. Female sterna. 361. *P. drymo*. 362. *P. ephyre*. 363-364. Nymph head and pronotum. 363. *P. drymo*. 364. *P. ephyre*. 365- 366. Caudal and lateral views, male paraprocts. 365. *P. ephyre*. 366. *P. drymo*.



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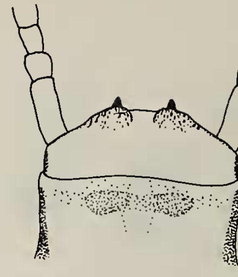

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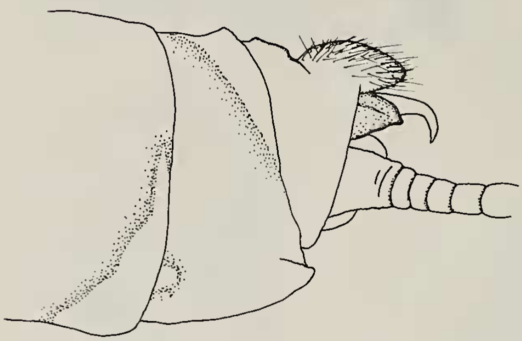

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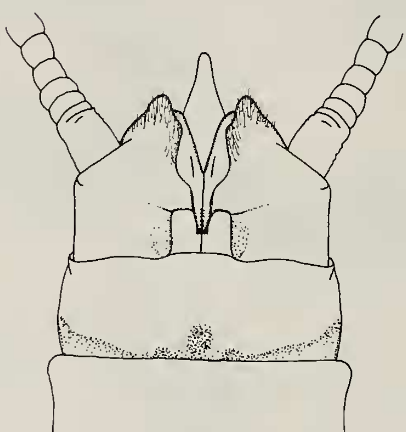

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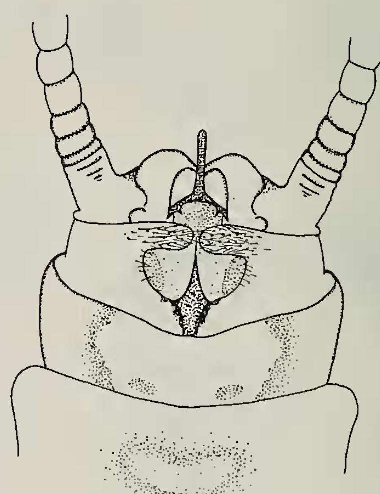

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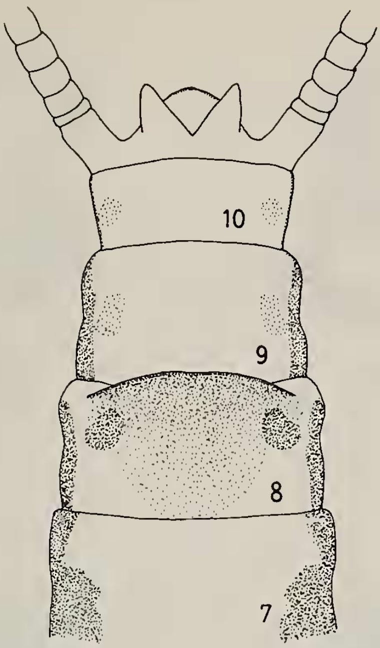
Figs. 367-372. Perlodidae male terminalia. 367-368. Lateral. 367. *Helopicus nalatus*. 368. *Hydroperla crosbyi*. 369-370. *C. clio*. 369. Dorsal. 370. Lateral, with everted aedeagus. 371-372. Dorsal. 371. *H. crosbyi*. 372. *Helopicus nalatus*.



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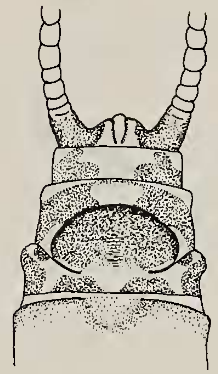

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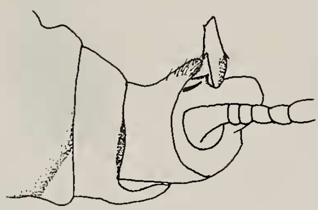

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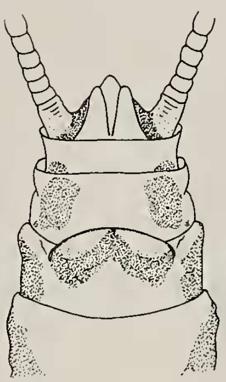

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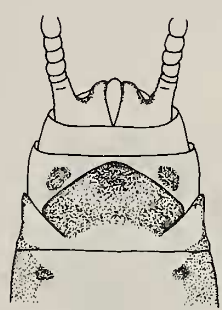

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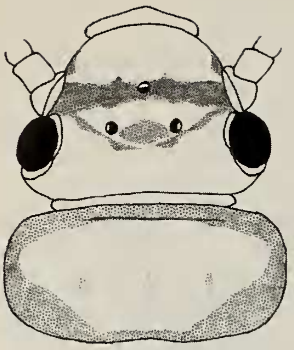
Figs. 373-377. Perlodidae terminalia. 373-376. Female sterna. 373. *C. clio*. 374. *Helopicus nalatus*. 375. *Hydroperla crosbyi*. 376. *H. fugitans*. 377. *H. fugitans*, lateral aspect of male terminalia.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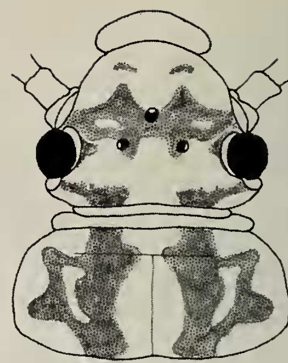
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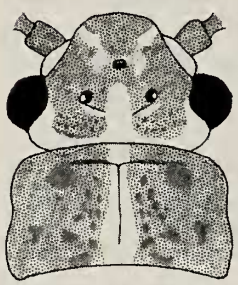
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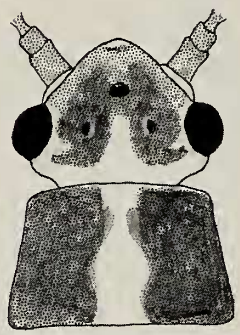
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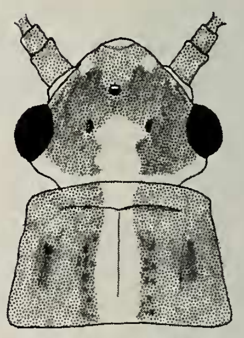
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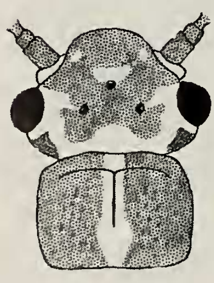
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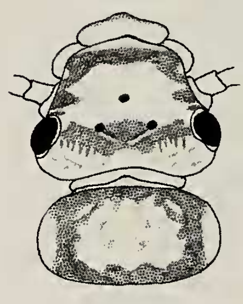
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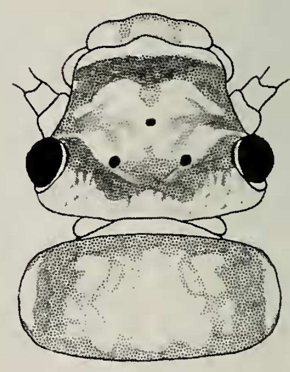
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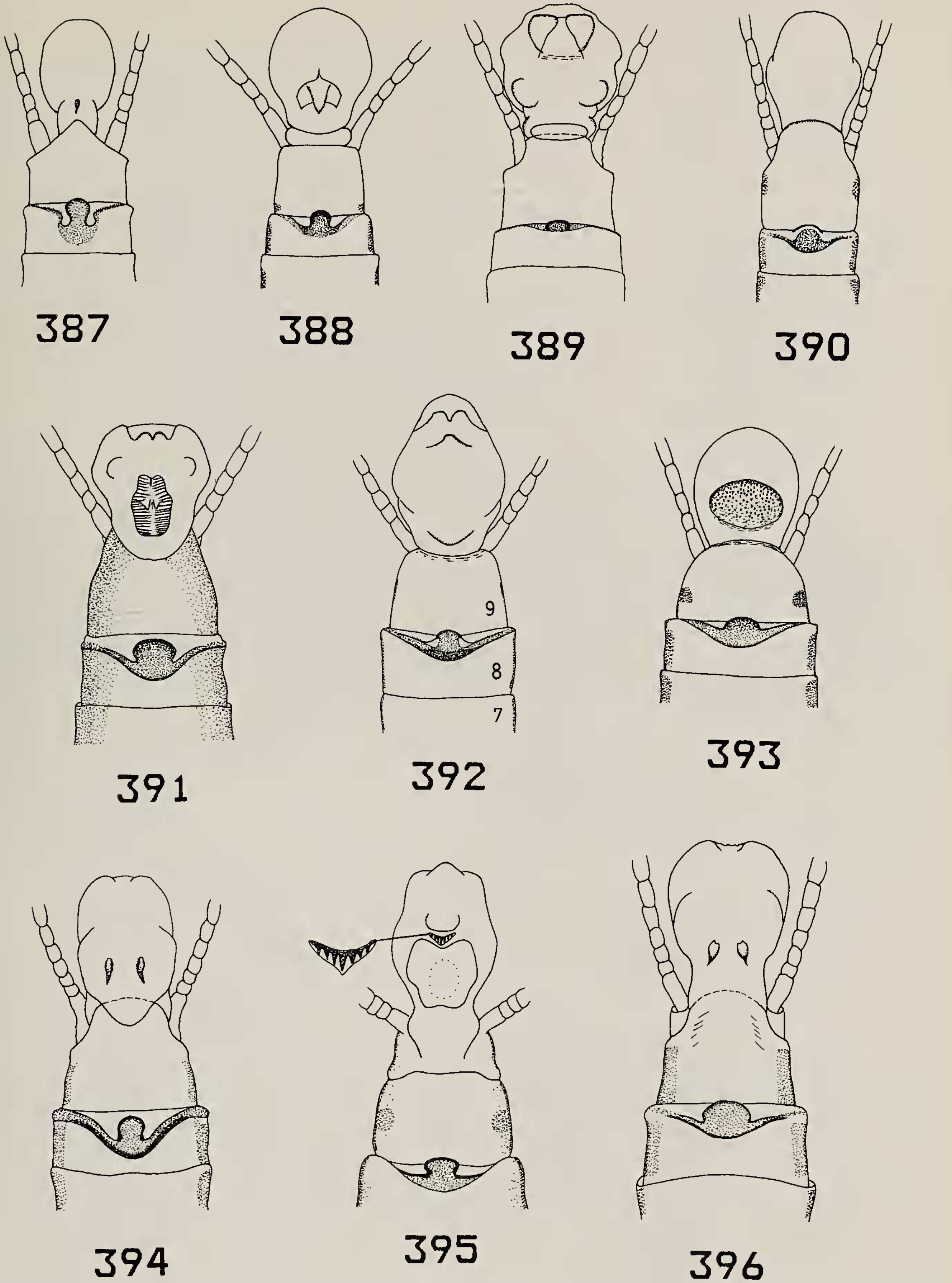
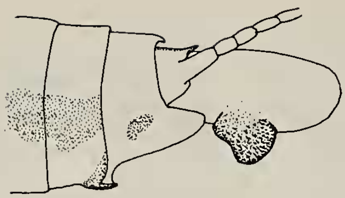
Figs. 378-386. Perlodidae head and pronotum. 378- 380. Nymphs. 378. *Helopicus nalatus*. 379. *Hydroperla crosbyi*. 380. *H. fugitans*. 381-383. Adults. 381. *Helopicus nalatus*. 382. *Hydroperla crosbyi*. 383. *H. fugitans*. 384-386. *C. clio*. 384. adult. 385. nymph. 386. variant of nymph.



Figs. 387-396. *Isoperla* male abdominal sterna and aedeagus. 387. *I. dicala*. 388. *I. decepta*. 389. *I. ouachita*. 390. *I. coushatta*. 391. *I. mohri*. 392. *I. bilineata*. 393. *I. burksi*. 394. *I. namata*. 395. *I. szczytkoi*. 396. *I. signata*.



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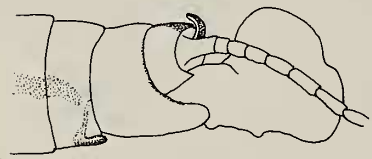

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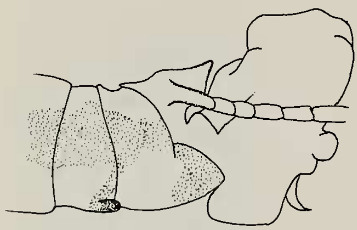

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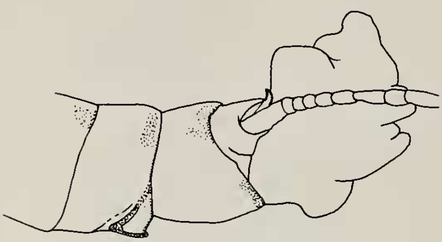

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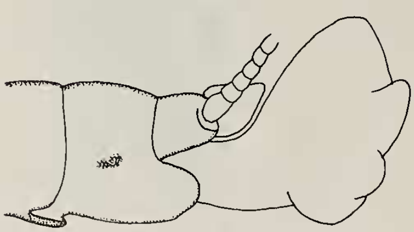

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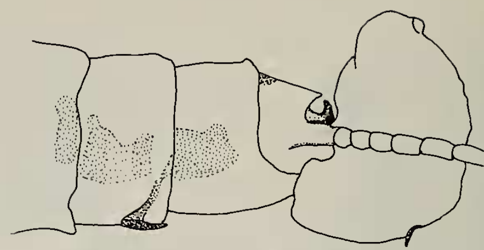

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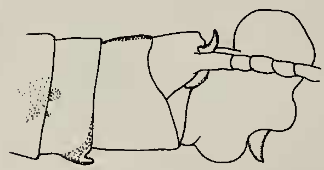

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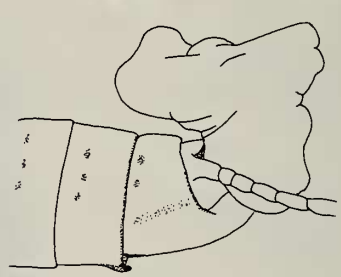

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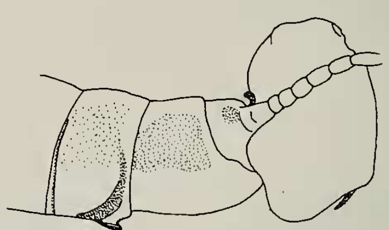

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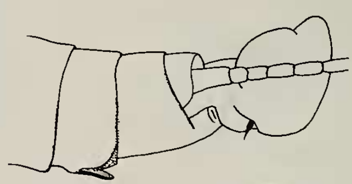

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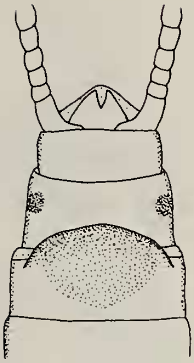
Figs. 397-406. *Isoperla* male terminalia. 397. I. burksi. 398. *I. coushatta*. 399. *I. mohri*. 400. *I. bilineata*. 401. *I. szczytkoi*. 402. *I. signata*. 403. *I. decepta*. 404. *I. ouachita*. 405. *I. namata*. 406. *I. dicala*.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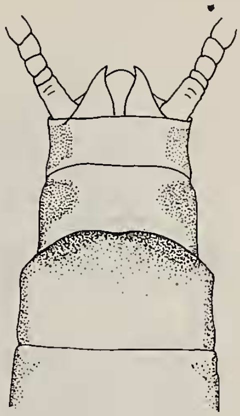
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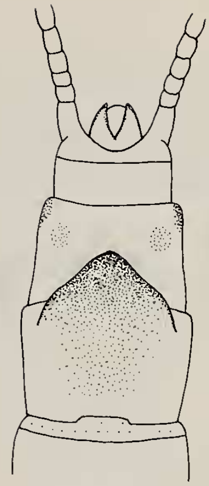
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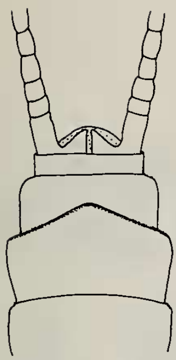
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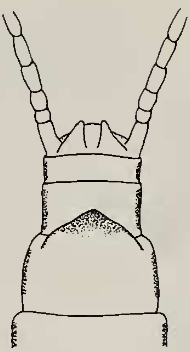
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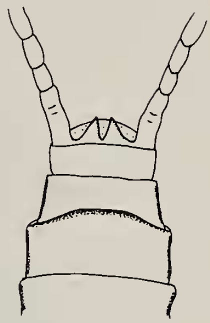
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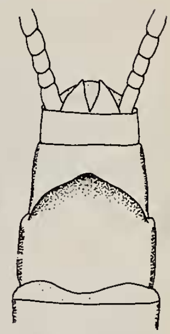
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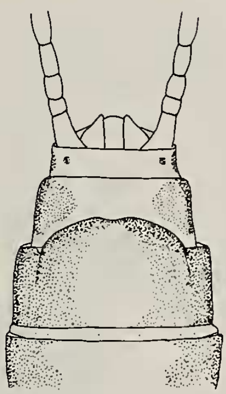
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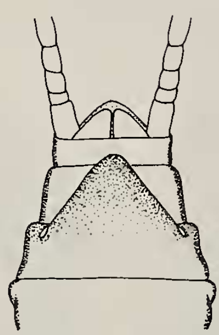
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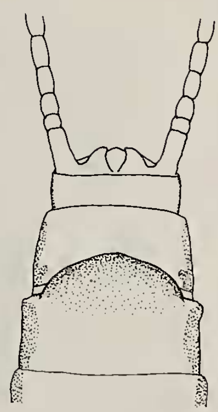
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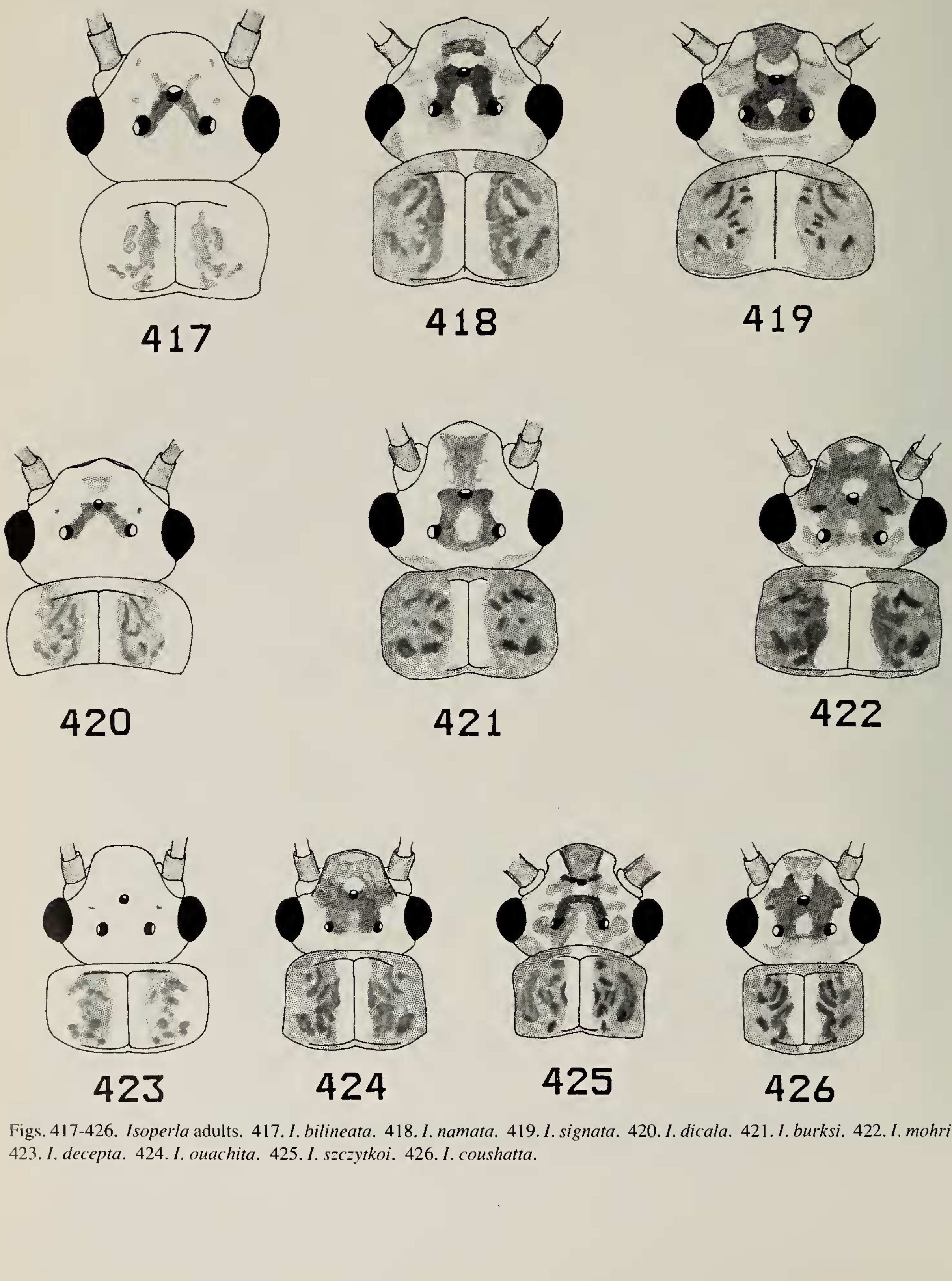
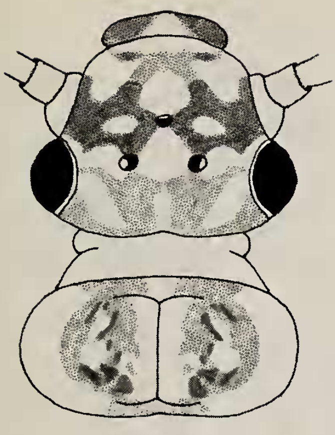
Figs. 407-416. *Isoperla* female terminal abdominal sterna. 407. *I. szczytkoi*. 408. *I. signata*. 409. *I. bilineata*. 410. *I. dicala*. 411. *I. coushatta*. 412. *I. decepta*. 413. I.ouachita. 414. *I. mohri*. 415. *I. burksi*. 416. *I. namata*.



Figs. 417-426. *Isoperla* adults. 417. *I. bilineata*. 418. *I. namata*. 419. *I. signata*. 420. *I. dicala*. 421. *I. burksi*. 422. *I. mohri*. 423. *I. decepta*. 424. *I. ouachita*. 425. *I. szczytkoi*. 426. *I. coushatta*.



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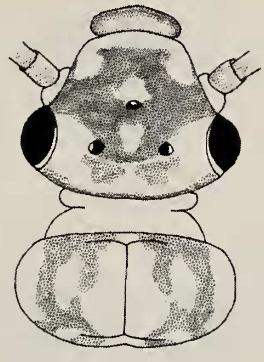

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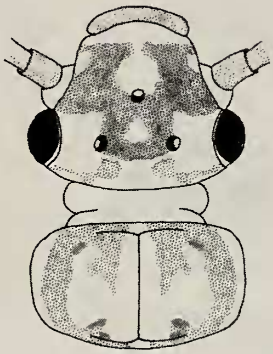

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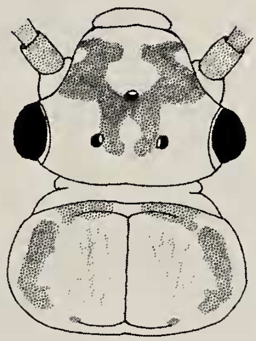

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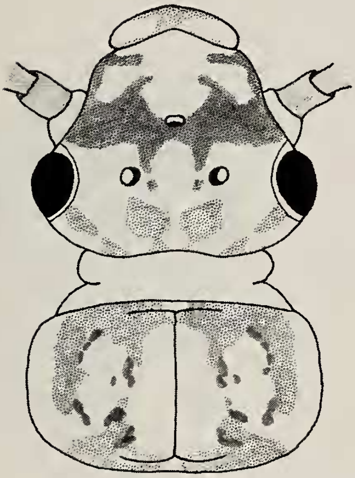

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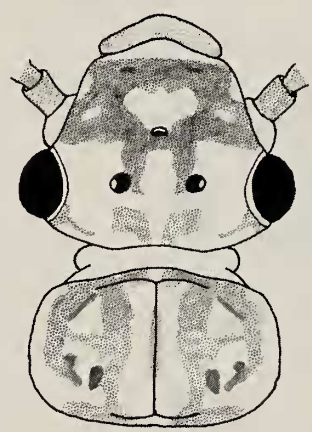

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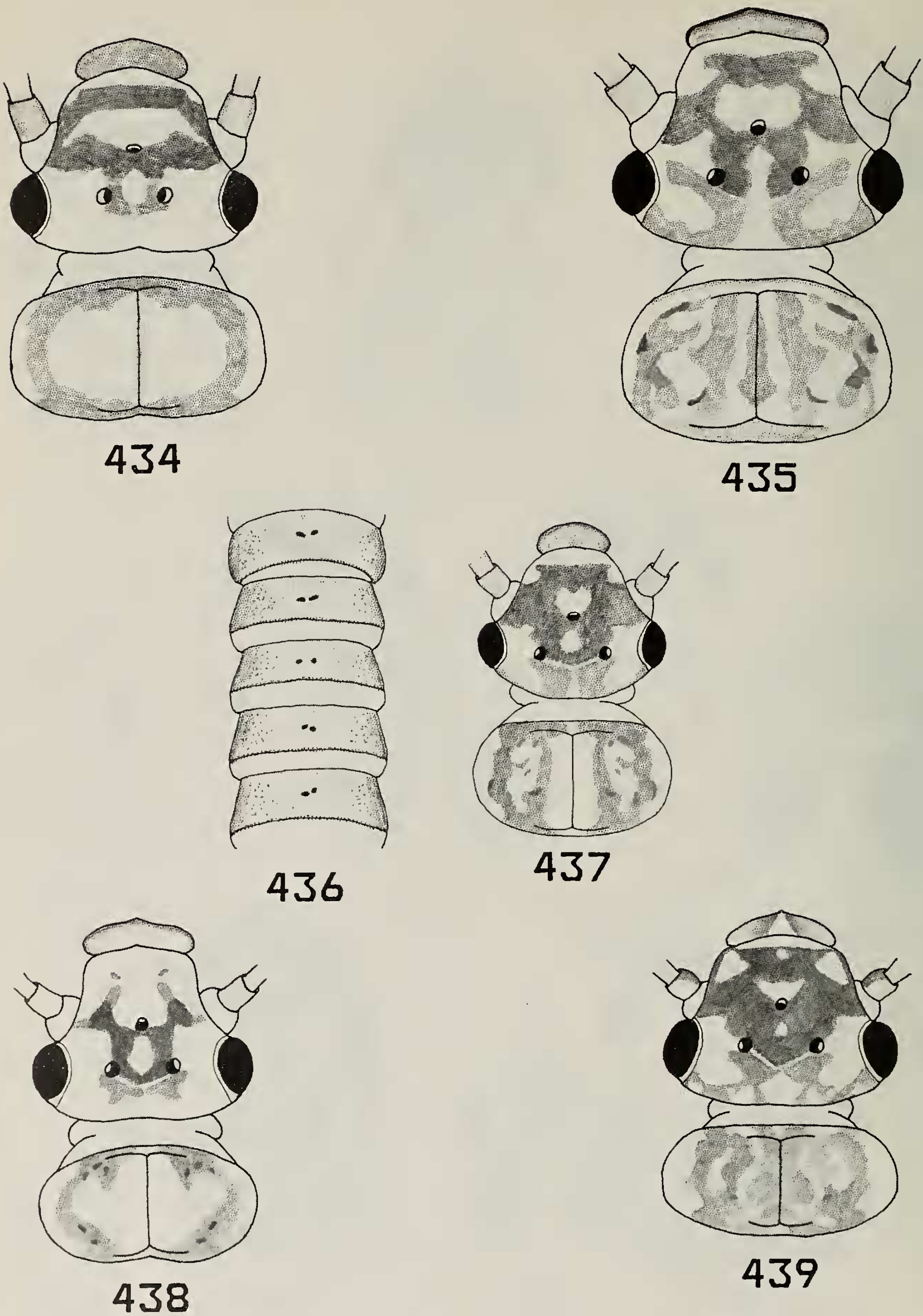
Figs. 427-433. *Isoperla* nymphs. 427. *I. bilineata.* 428. *I. coushatta.* 429. *I. mohri.* 430. *I. ouachita.* 431. *I. ouachita*, variant. 432. *I. namata.* 433. *I. namata*, variant.



Figs. 434-439. *Isoperla* nymphs. 434. *I. signata*. 435. *I. szczytkoi*. 436-437. *I. decepta*. 436. sterna. 437. head and pronotum. 438. *I. burksi*. 439. *I. dicala*.

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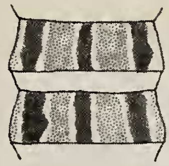

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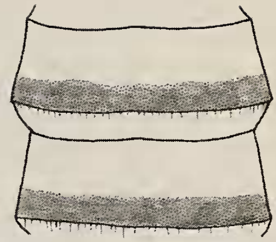

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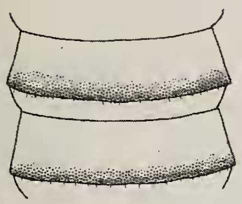

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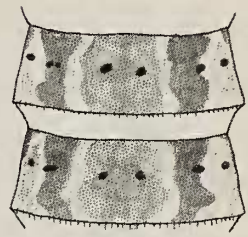

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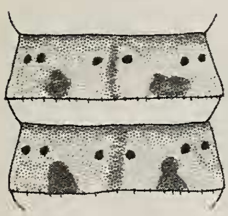

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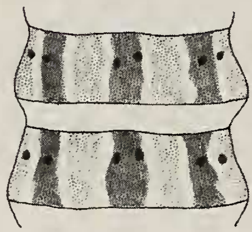

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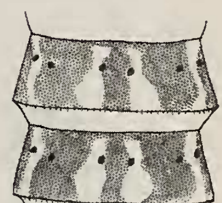

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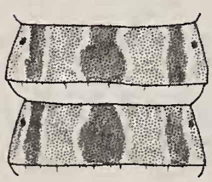

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Figs. 440-449. *Isoperla* nymphal abdominal terga. 440. *I. ouachita*. 441. *I. coushatta*. 442. *I. signata*. 443. *I. burksi*. 444. *I. szczytkoi*. 445. *I. mohri*. 446. *I. decepta*. 447. *I. namata*. 448. *I. bilineata*. 449. *I. dicala*.

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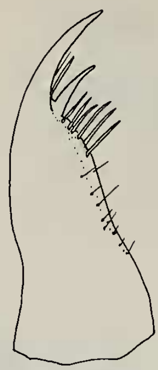

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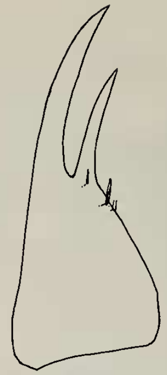

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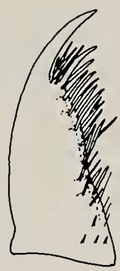

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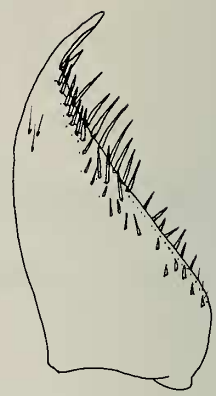

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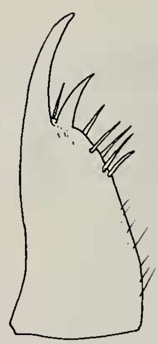

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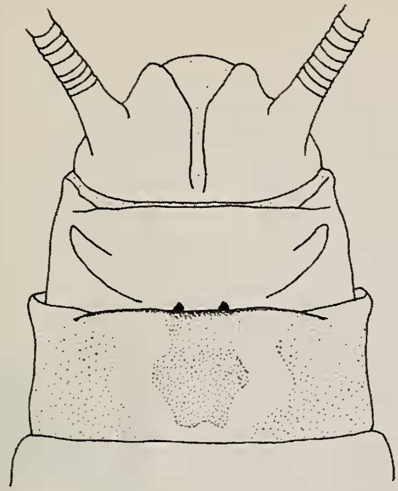
Figs. 450-459. *Isoperla* nymphal lacinia. 450. I. dicala. 451. *I. signata*. 452. *I. burksi*. 453. *I. ouachita*. 454. *I. namata*. 455. *I. mohri*. 456. *I. szczytkoi*. 457. *I. coushatta*. 458. *I. decepta*. 459. *I. bilineata*.



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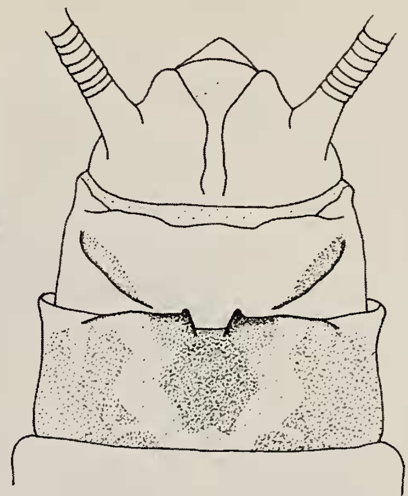

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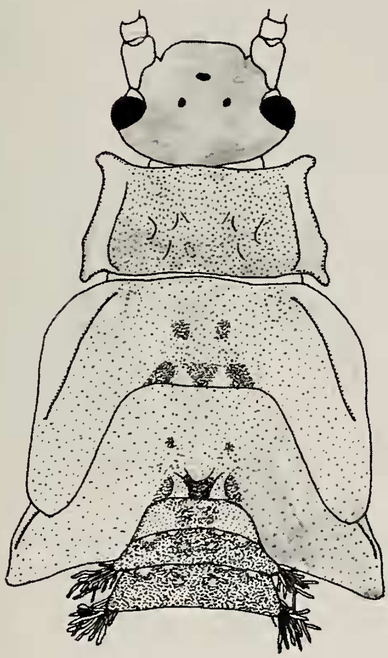

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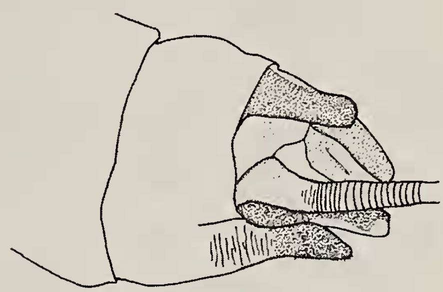

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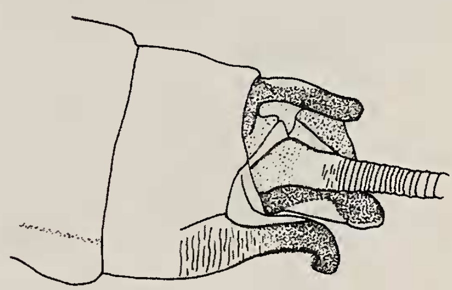

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Figs. 460-464. *Pteronarcys.* 460-461. Female abdominal sterna. 460. *P. dorsata.* 461. *P. pictetii.* 462. Nymph of *P. pictetii.* 463-464. Male terminalia. 463. *P. dorsata.* 464. *P. pictetii.*

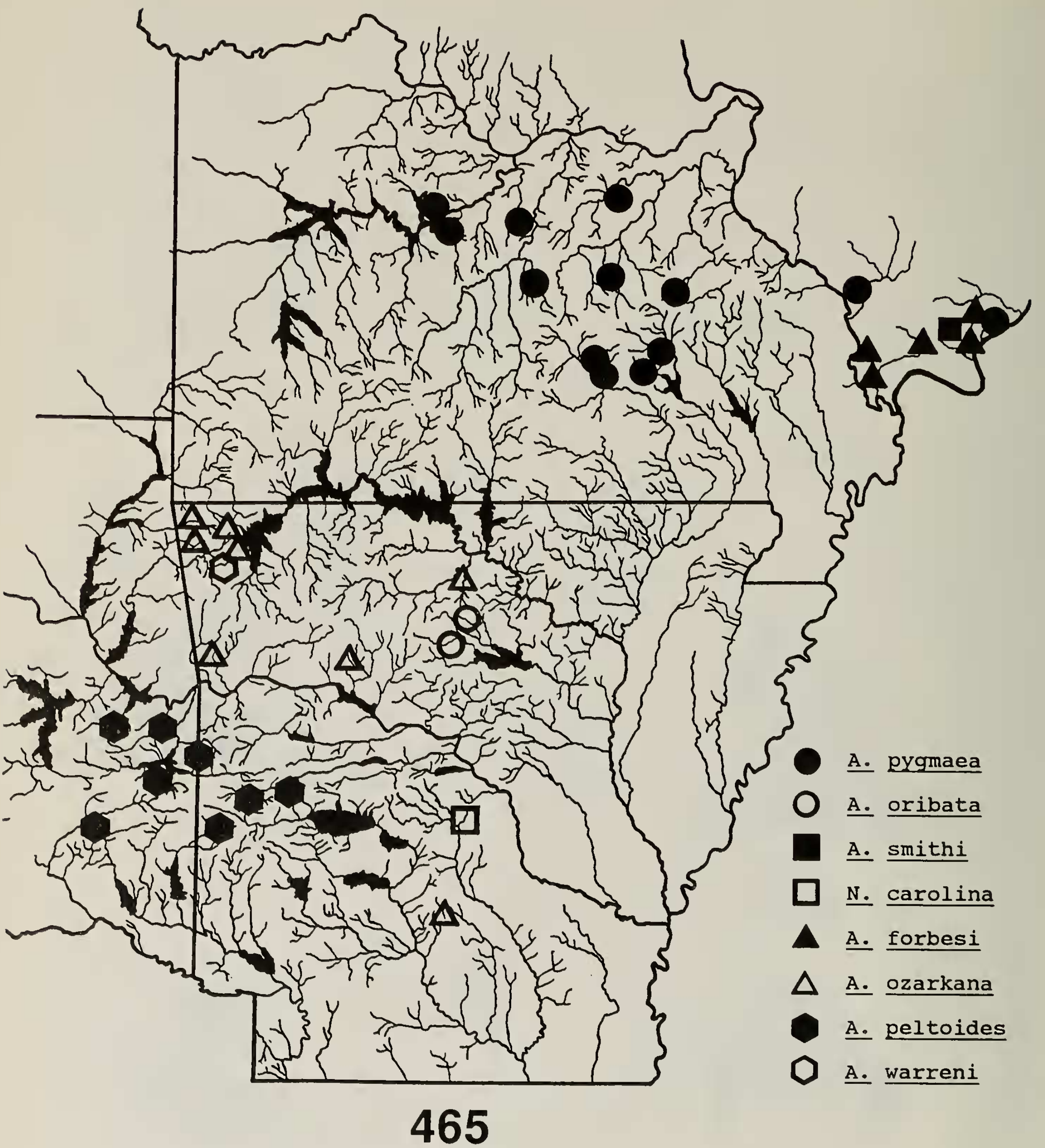

Fig. 465. Distributions of 8 Capniidae species within the Ozark-Ouachita Mountains.

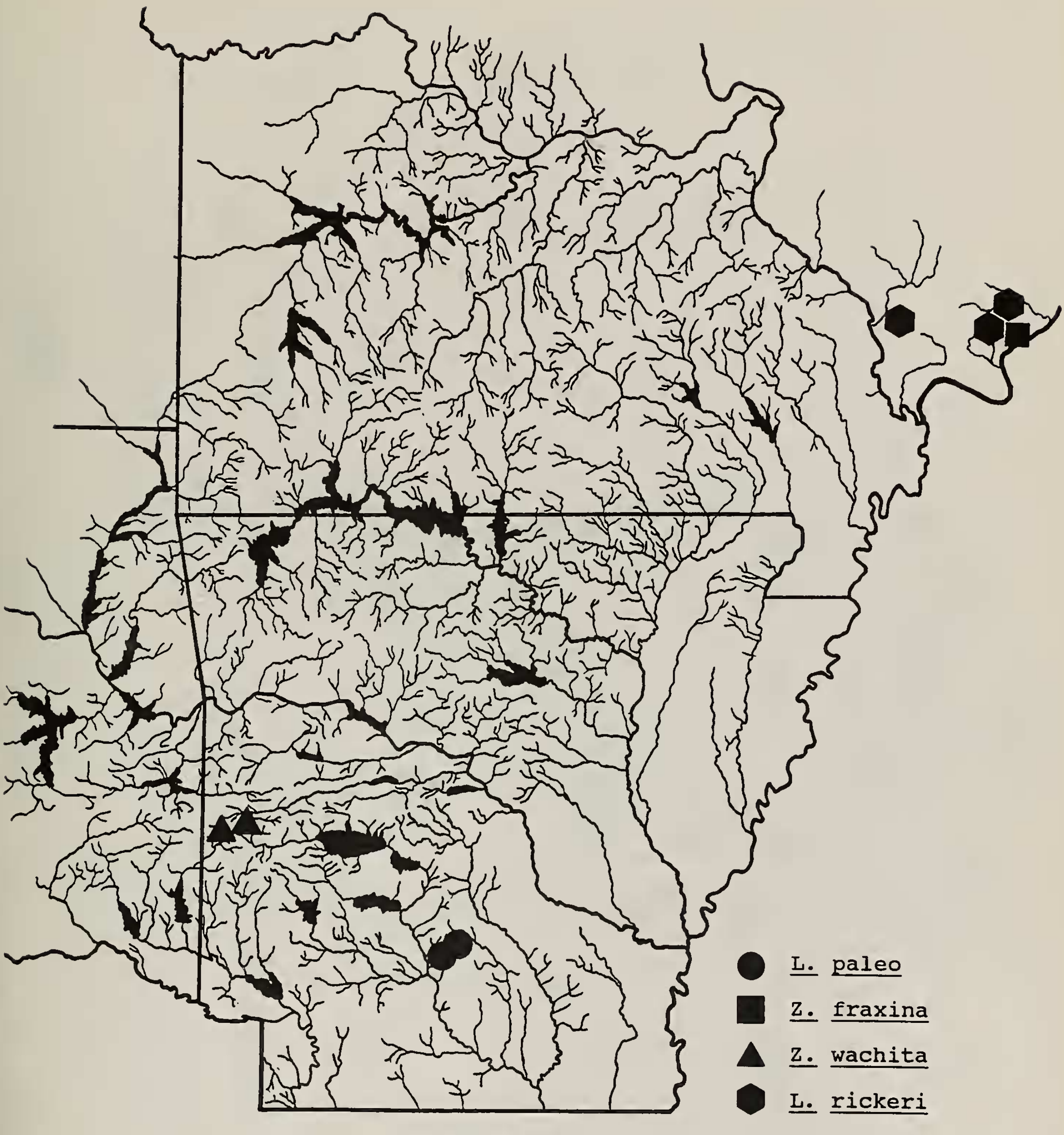

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Fig. 466. Distributions of 4 Leuctridae species within the Ozark-Ouachita Mountains.

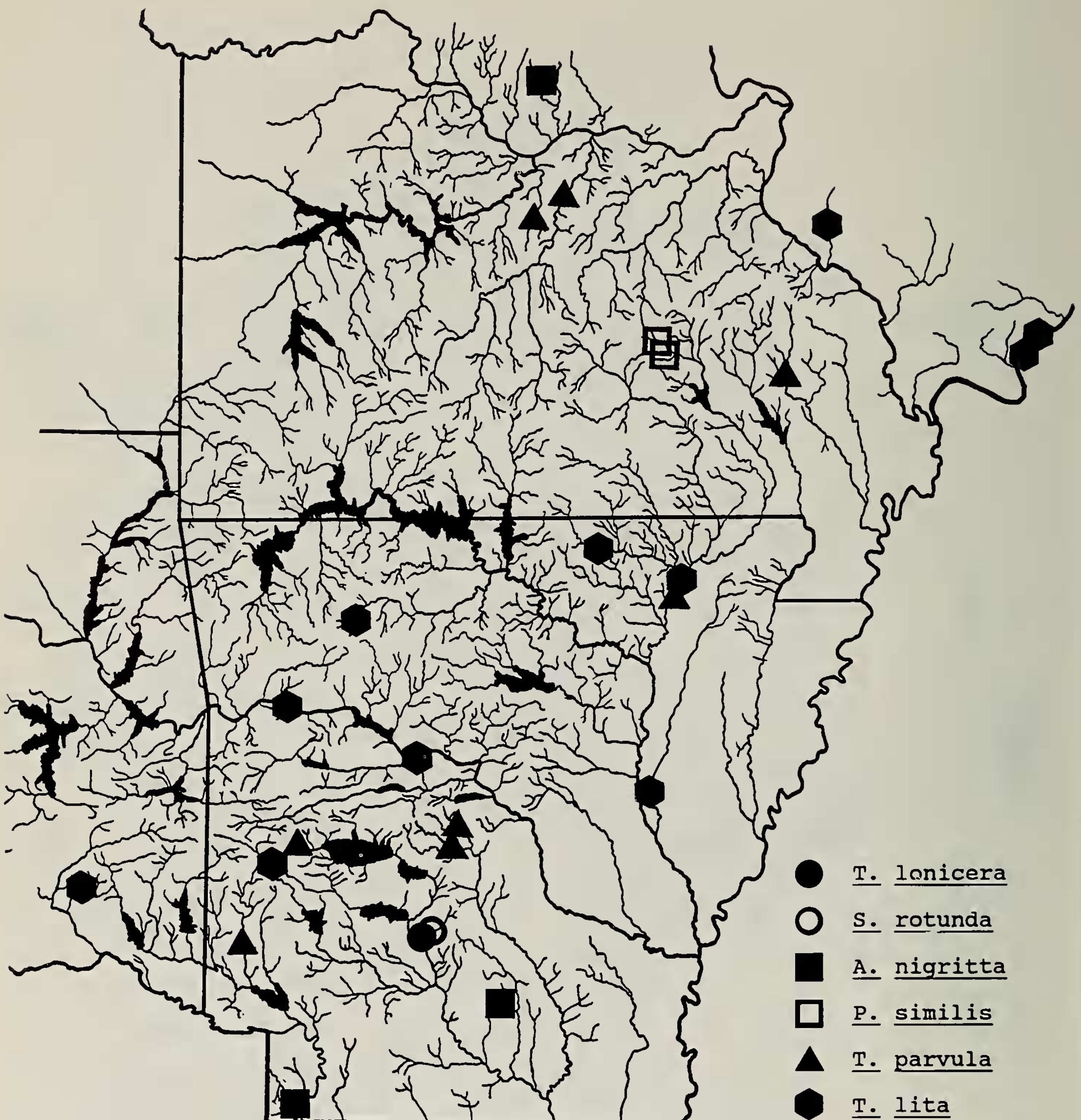

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Fig. 467. Distributions of 3 Taeniopterygidae and 3 Nemouridae species within the Ozark-Ouachita Mountains.

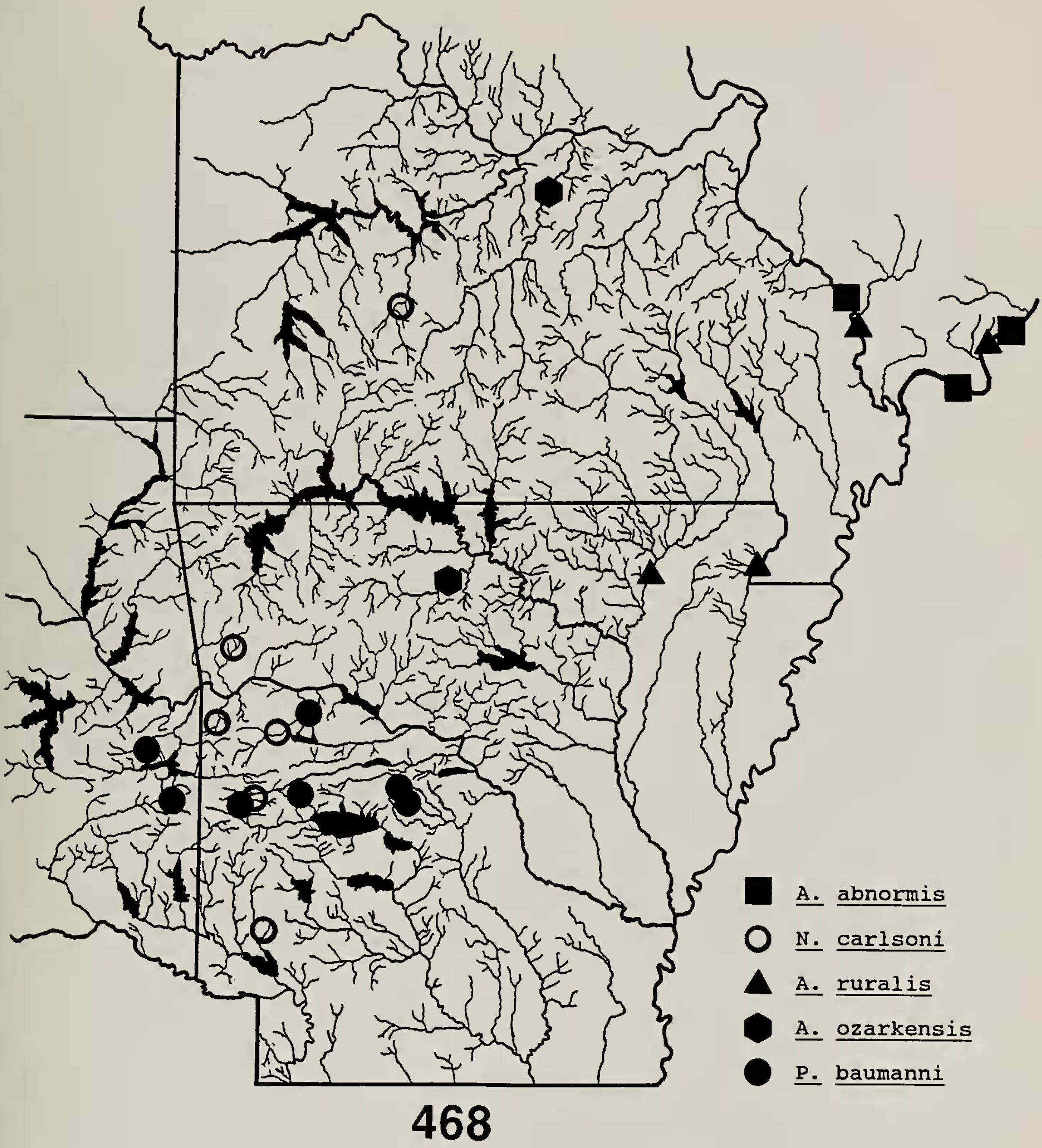

Fig. 468. Distributions of 5 Perlidae species within the Ozark-Ouachita Mountains.

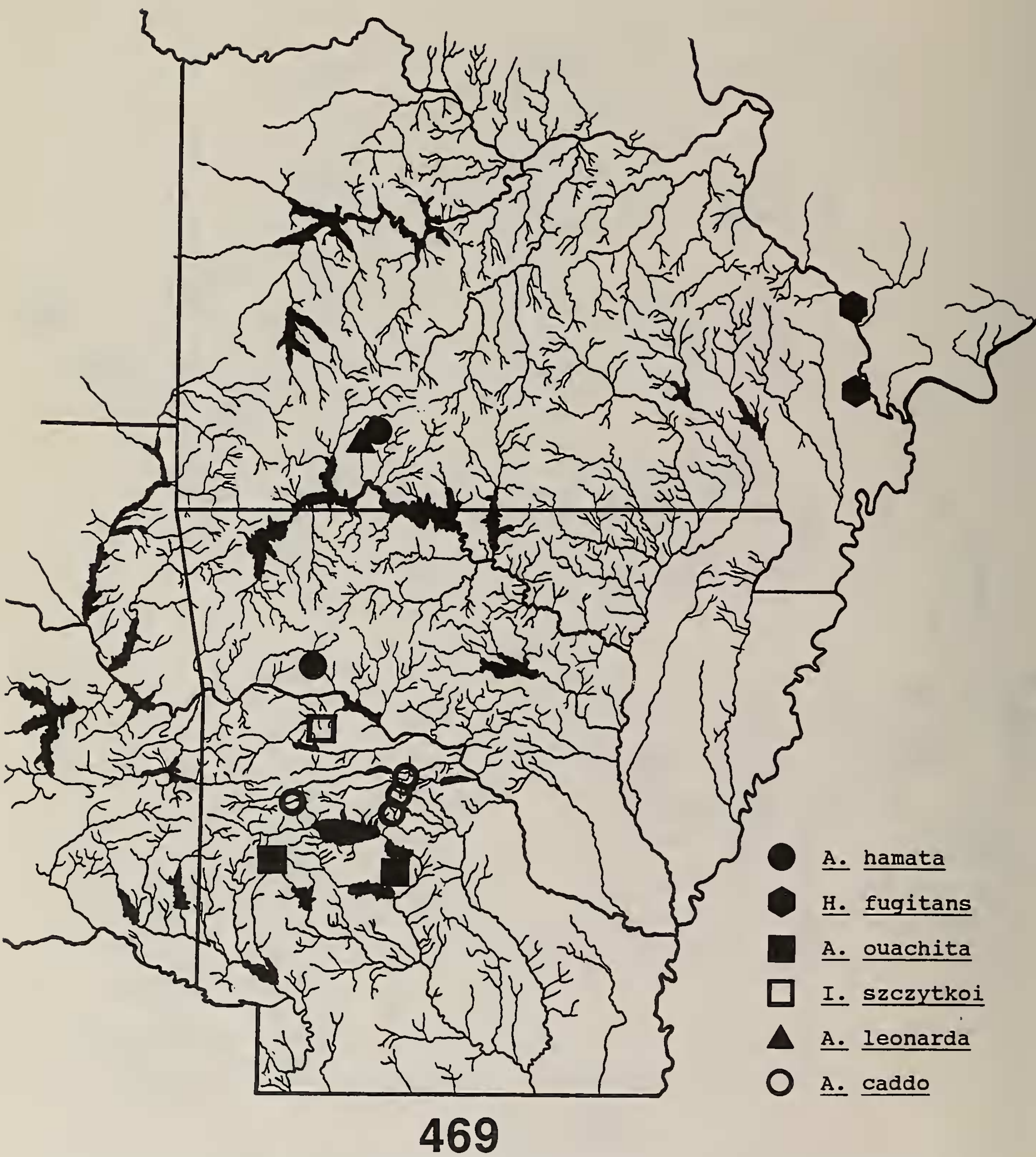

Fig. 469. Distributions of 4 Chloroperlidae and 2 Perlodidae species within the Ozark-Ouachita Mountains.